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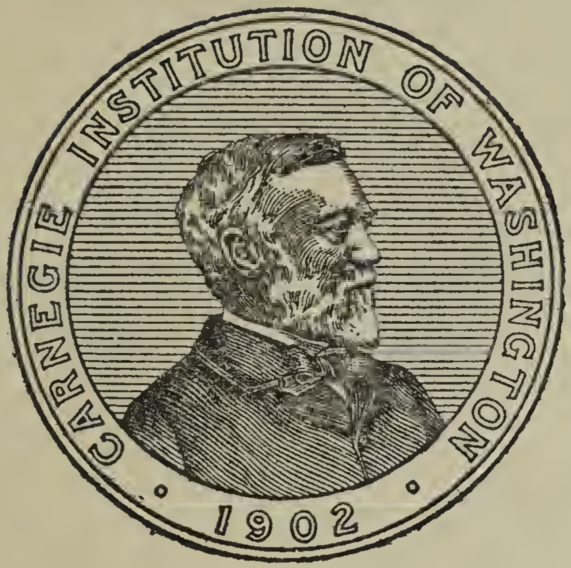

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# CONTRIBUTIONS TO PALAEONTOLOGY
## FROM CARNEGIE INSTITUTION OF WASHINGTON

### PAPERS CONCERNING THE PALAEONTOLOGY OF THE CRETACEOUS AND LATER TERTIARY OF OREGON, OF THE PLIOCENE OF NORTHWESTERN NEVADA, AND OF THE LATE MIOCENE AND PLEISTOCENE OF CALIFORNIA

By
CHARLES W. GILMORE, JOHN H. MAXSON, JOHN C. MERRIAM,
and CHESTER STOCK

PUBLISHED BY CARNEGIE INSTITUTION OF WASHINGTON
WASHINGTON, SEPTEMBER 1928

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## LIST OF PAPERS

I. An Ichthyosaurian Reptile from Marine Cretaceous of Oregon. By John C. Merriam and Charles W. Gilmore. Pages 1 to 4, and 1 text-figure.

II. A Further Contribution to the Mammalian Fauna of the Thousand Creek Pliocene, Northwestern Nevada. By John C. Merriam and Chester Stock. Pages 5 to 21, 3 plates and 14 text-figures.

III. A Peccary from the McKittrick Pleistocene, California. By Chester Stock. Pages 23 to 27, and 7 text-figures.

IV. Tanupolama, a New Genus of Llama from the Pleistocene of California. By Chester Stock. Pages 29 to 37, and 6 plates.

V. Canid and Proboscidean Remains from the Ricardo Deposits, Mohave Desert, California. By Chester Stock. Pages 39 to 47, 4 plates and 1 text-figure.

VI. A Tooth of Hipparion mohavense from the Puente Formation, California. By Chester Stock. Pages 49 to 53, and 1 text-figure.

VII. Merychippus isonesus (Cope) from the Later Tertiary of the Crooked River Basin, Oregon. By John H. Maxson. Pages 55 to 58, and 1 text-figure.

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# I

# AN ICHTHYOSAURIAN REPTILE FROM MARINE CRETACEOUS OF OREGON

BY JOHN C. MERRIAM AND CHARLES W. GILMORE

With one text-figure

# AN ICHTHYOSAURIAN REPTILE FROM MARINE CRETACEOUS OF OREGON

By John C. Merriam and Charles W. Gilmore

The recent discovery by Professor E. L. Packard of two vertebral centra in the marine Cretaceous rocks of eastern Oregon marks the first occurrence of ichthyosaurian reptiles in the Cretaceous of the Pacific Coast region of North America. Although Cretaceous ichthyosaurs have long been known from England, France, East Indies, Australia, New Zealand and South America, their presence on this continent was not announced until 1905, when the senior author reported[1] them in the Benton formation of Wyoming. A second occurrence in the same region and in the same formation was recorded by the junior author[2] in 1914. Both of these records were based upon fragmentary specimens entirely adequate to establish their ichthyosaurian affinities, but insufficient to determine their generic affiliations.

The Oregon specimens likewise are too scanty for generic identification, but their geological occurrence intermediate between the well-known *Ophthalmosaurus* (*Baptanodon*) of the Sundance (Jurassic) and Upper Cretaceous ichthyosaurs of the Mowrey shales (Benton) makes their discovery of considerable scientific interest. With this extension of the known geographical and geological range of these Marine reptiles in North America, we may look forward to the discovery of better preserved material on which to base specific studies.

The materials of Professor Packard's find consist of one complete vertebral centrum and the lateral half of another. They were found about one-third of a mile apart in Mitchell Quadrangle, NE. ¼ Sec. 23, T. 11-S, R 21E, Wheeler County, Oregon. Although the two centra are of approximately the same size, their occurrence so far apart would indicate probability of their pertaining to different individuals. The better preserved centrum is either the third or fourth of the cervical series, while the other is from the lumbar or posterior dorsal region. Viewed from the front, the cervical (figs. A and B) is pentagonal in outline and much narrowed ventrally, with a slight suggestion of a hypophysial keel. The ventral contraction is pronounced, and in this respect the vertebra bears a striking resemblance to the atlas-axis complex of *Ophthalmosaurus*. The Oregon vertebræ are, however, fully one-third larger in all dimensions than the largest *Ophthalmosaurus* (*O. robustus* (Gilmore)) of which measurements are available.

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[1] J. C. Merriam, Science, n. s., vol. 22, No. 568, pp. 640–641.

[2] C. W. Gilmore, Science, n. s., vol. 39, No. 997, p. 210.

*Table of comparative measurements of third cervical vertebræ*

| | Oregon specimen | *Ophthalmosaurus robustus* type | *O. icenicus* |
|---|---|---|---|
| | *mm.* | *mm.* | *mm.* |
| Greatest width of centrum, over all | 137 | 100 | ........ |
| Greatest width of centrum | 111 | .......... | 66 |
| Greatest height of centrum at center | 127 | .......... | 74 |
| Greatest antero posterior diameter of centrum | 45.7 | 34 | 28 |

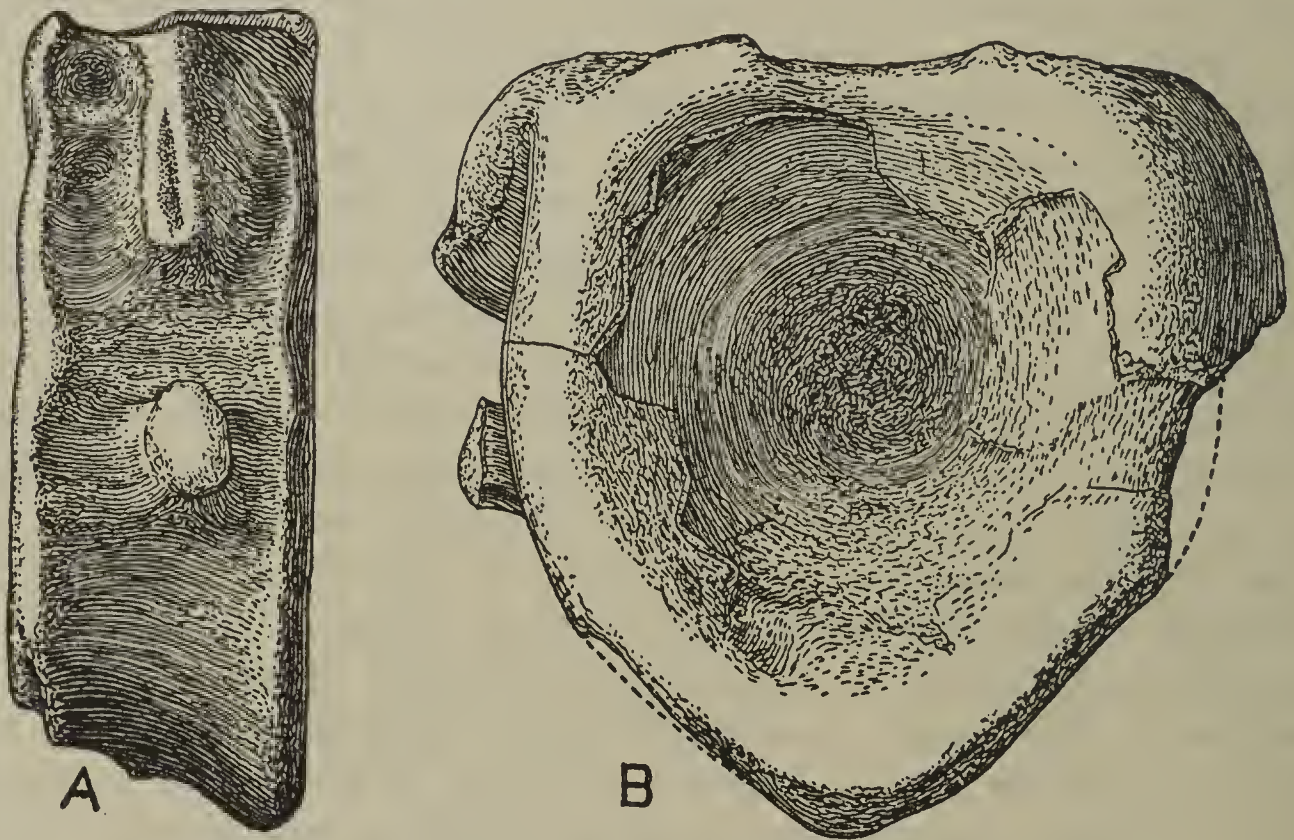

FIG. 1—Cervical vertebra of an ichthyosaurian reptile.

A, viewed from right side; B, viewed from the front. One-half natural size.

In comparison with cervical vertebræ of other ichthyosaurians, no outstanding peculiarities in form or structure, beyond those mentioned, were observed, and this fact adds to the difficulty of determining their relationships.

These specimens may represent an ichthyosaur genus new to North America, but more clearly diagnostic materials are required before the affinities can be demonstrated.

## II

# A FURTHER CONTRIBUTION TO THE MAMMALIAN FAUNA OF THE THOUSAND CREEK PLIOCENE, NORTHWESTERN NEVADA

BY JOHN C. MERRIAM AND CHESTER STOCK

WITH THREE PLATES AND FOURTEEN TEXT-FIGURES

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# A FURTHER CONTRIBUTION TO THE MAMMALIAN FAUNA OF THE THOUSAND CREEK PLIOCENE, NORTHWESTERN NEVADA

By John C. Merriam and Chester Stock

## INTRODUCTION

Since publication of the description and discussion of the Thousand Creek fauna in 1911,[1] further collecting in the Thousand Creek beds of northwestern Nevada by parties from the University of California has furnished additional palæontological materials on which the recognition of forms new to the fauna has been based and on which previously described species have become better known.

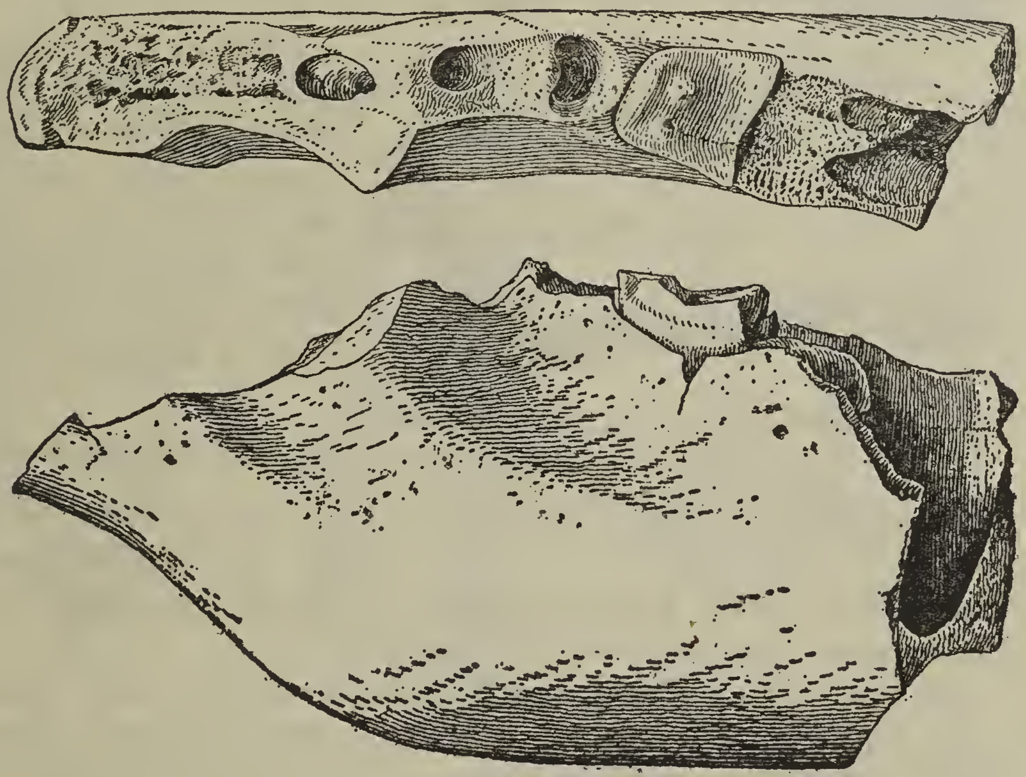

Fig. 1. *Ælurodon* sp. Mandibular fragment, No. 27248 U. C. Coll.; lateral and superior views, ×1.0. Thousand Creek Pliocene, Nevada.

While the relationships of the fauna were discussed some years ago,[2] a description of the newly obtained material, with the exception of the badger remains described by Butterworth,[3] has never been published.

The illustrations for this paper have been prepared by John L. Ridgway.

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[1] J. C. Merriam, *Tertiary mammal beds of Virgin Valley and Thousand Creek in Northwestern Nevada, Pt. II: Vertebrate Faunas*, Univ. Calif. Publ. Bull. Dept. Geol., vol. 6, pp. 199–304, pls. 32–33, 1911.

[2] J. C. Merriam, *Relationships of Pliocene mammalian faunas from the Pacific Coast and Great Basin provinces of North America*, Univ. Calif. Publ., Bull. Dept. Geol., vol. 10, pp. 421–443, 1917.

[3] E. Butterworth, *A new mustelid from the Thousand Creek Pliocene of Nevada*, Univ. Calif. Publ., Bull. Dept. Geol., vol. 10, pp. 21–24, 1916.

## DESCRIPTION OF MATERIAL

### Ælurodon sp.

Two mandibular fragments, No. 27248 U. C. C. (fig. 1), represent a large type of dog, presumably related to the genus *Ælurodon* and comparable in size to *Æ. wheelerianus*. In this specimen the jaw is heavy, although of smaller size than the *Ælurodon* jaws from the Ricardo which have been referred provisionally to *Æ. aphobus*. Unfortunately all that remains of the lower dentition is the broken part of the heel of $M\bar{1}$. The heel region of this tooth narrows posteriorly as in *Æ. wheelerianus*.

### Pseudælurus? sp.

An anterior portion of a ramus, No. 27247 U. C. C. (fig. 2), appears to belong to *Pseudælurus*. This specimen is distinctly smaller than the type of *P. intrepidus* Leidy. The roots of $P\bar{3}$ and $P\bar{4}$ remain in the jaw. In front of the anterior root of $P\bar{3}$ is a very small alveolus for a single-rooted tooth. The root of the canine is flattened transversely. Two mental foramina are present, one situated below the anterior root of $P\bar{3}$, the second below the posterior root of this tooth.

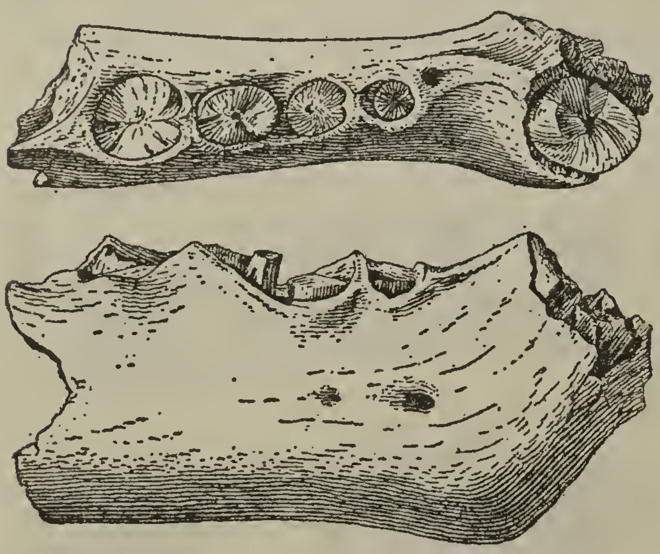

Fig. 2. *Pseudælurus*? sp. Mandibular fragment, No. 27247 U. C. Coll.; lateral and superior views, ×1.0. Thousand Creek Pliocene, Nevada.

### Pliohippus near fairbanksi Merriam

A number of cheek-teeth of horses of the *Pliohippus* type found in the Thousand Creek beds represent a form belonging in or near the group of *Pliohippus fairbanksi* or *P. supremus*.

Of the upper cheek-teeth unfortunately only fragmentary material has been secured, no complete teeth being known. The crowns of the upper cheek-teeth are strongly curved and well cemented. In the teeth available the fossettes are not of unusual width and the enamel border is comparatively little folded. The most important folds are those at the postero-internal angle of the anterior fossette. These folds taken with the type of the post-protoconal fold indicate that the nature of the union between protoloph and metaloph was much as in *P. fairbanksi*. The complete protocone is not known; so far as can be determined it was small and only slightly compressed laterally. So far as the characters of the upper cheek-teeth are concerned this species seems to belong nearer to the *P. fairbanksi* type as represented in the Ricardo and Rattlesnake forms than to any other species, unless it be *P. supremus*.

### Pliohippus sp.

Several lower cheek-teeth from the Thousand Creek beds represent a *Pliohippus* of a type near *P. fairbanksi* of the Ricardo Pliocene. These teeth are long crowned and very heavily cemented. The outer walls of the protoconid and paraconid are convex. The metaconid-metastylid column is short anteroposteriorly and its inner gutter tends to be angular. Specimen

22423, including P$\overline{2}$ to P$\overline{4}$ and an associated M$\overline{3}$ (fig. 3a, b), closely resembles No. 21346 from the Ricardo and No. 22388 from the Rattlesnake. The latter specimen has been referred to *Pliohippus spectans* (Cope). The M$\overline{3}$ associated with the premolars in the specimen from Thousand Creek also closely resembles the corresponding tooth of No. 22388 from the Rattlesnake.

A M$\overline{2}$ from another locality, No. 2745, shows some resemblance to that of a Ricardo species, No. 21789, referred to *P. tantalus*, but its similarity to the *P. fairbanksi* form of the Rattlesnake might be as close if a specimen of corresponding stage of wear were available for comparison.

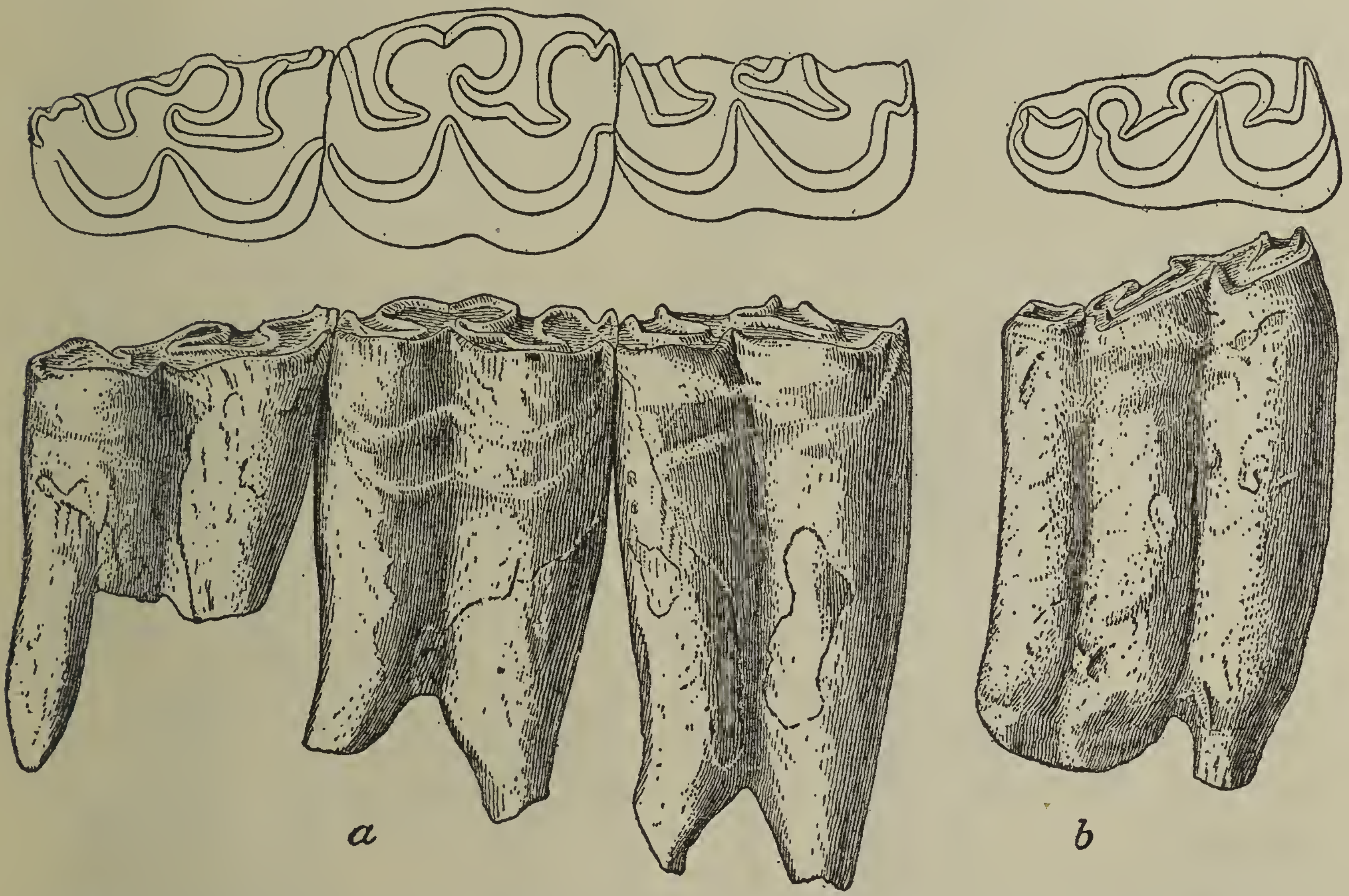

Fig. 3. *Pliohippus* sp. Lower cheek-teeth, No. 22423 U. C. Coll.; lateral and occlusal views, ×1.0. *a*, P$\overline{2}$ to P$\overline{4}$; *b*, M$\overline{3}$. Thousand Creek Pliocene, Nevada.

*Measurements (in millimeters) of No. 22423*

| | |
|---|---|
| P$\overline{2}$, antero-posterior diameter | 26. |
| P$\overline{2}$, greatest transverse diameter | 16. |
| P$\overline{3}$, antero-posterior diameter | 26.1 |
| P$\overline{3}$, greatest transverse diameter | 18.3 |
| P$\overline{4}$, antero-posterior diameter | 26.2 |
| P$\overline{4}$, transverse diameter | |
| M$\overline{3}$, antero-posterior diameter | 30. |
| M$\overline{3}$, greatest transverse diameter | 11.4 |

### Hipparion (Neohipparion) leptode Merriam

A fragmentary skull and lower jaw of a *Hipparion*, No. 27126 U. C. Coll., found by Miss Annie M. Alexander and Miss Louise Kellogg in the Thousand Creek beds in 1920 give a nearly complete representation of the upper and lower dentition. Associated with this specimen and undoubtedly belonging to the same individual are the remains of its front feet.

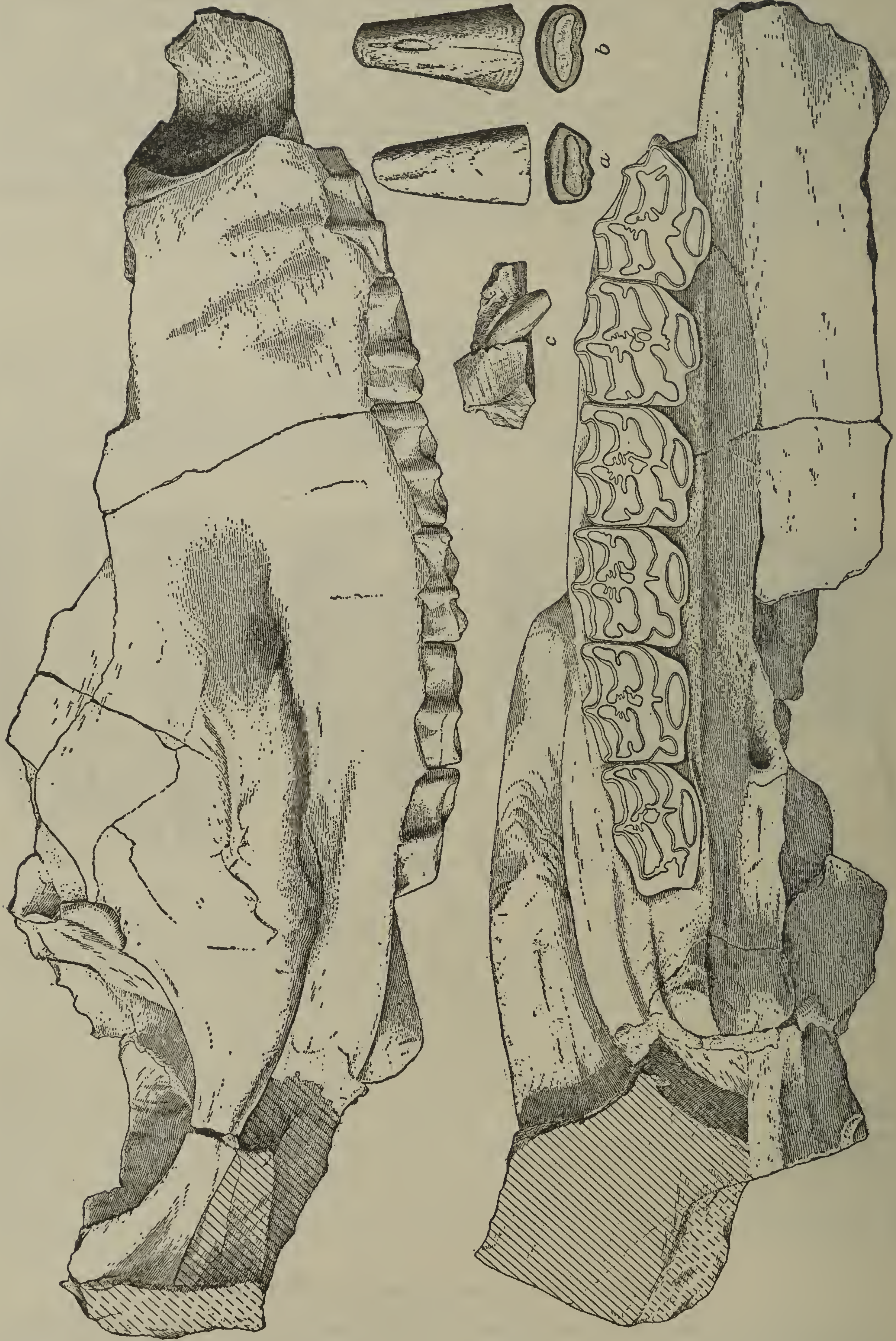

Fig. 4. *Hipparion* (*Neohipparion*) *leptode* Merriam. Skull fragment and superior dentition, No. 27126 U. C. C.; lateral and inferior views, ×0.66. *a* and *b*, superior incisors; *c*, superior canine. Thousand Creek Pliocene, Nevada.

In No. 27126 only a small portion of the lower orbital rim is preserved. Below and anterior to this border the crista facialis extends forward and is perhaps somewhat accentuated as a result of little crushing to which the side of the face has been subjected. The crista descends and disappears above the anterior end of M$\underline{1}$. Malar and lachrymal fossæ are not defined. The surface of the maxillary anterior to P$\underline{2}$ and above the palatal border forms a deep concavity (fig. 4).

The palatal portion of the skull is likewise poorly preserved. The posterior palatine foramen lies opposite the anterior end of M$\underline{3}$. The maxillary tubercle is not large and separates a broad groove situated along its inner side from a short and narrow groove behind the last molar.

With the possible exception of *Hipparion mohavense* from the Ricardo, the dentition of no other *Hipparion* species of the Great Basin or California Tertiary is as completely known as that in the present specimen. A single upper incisor, I$\underline{2}$?, is shown in figure 4*a*. The upper canine (fig. 4*c*), is very small. The upper cheek-tooth series, P$\underline{2}$ to M$\underline{3}$, is completely preserved. P$\underline{1}$ is absent. The teeth (fig. 4) are well cemented. They are characterized by having large and considerably elongated protocones and rather complicated enamel folds bordering the fossettes. In the premolars the inner wall of the protocone tends to be flattened and the antero-external end is pointed and is directed outward and forward toward the inner wall of the protoconule. The anteroposterior diameter of the protocone is more than twice as great as the transverse diameter. The hypocone is small. The pli caballin projects inward and slightly forward in M$\underline{3}$, directly inward in M$\underline{2}$ and M$\underline{1}$, and inward and backward in P$\underline{4}$. In P$\underline{3}$ and in P$\underline{2}$ this structure is broadened and shows evidence of division. Although the enamel borders of the fossettes show numerous plications, particularly the posterior border of the pre-fossette and the anterior border of the post-fossette, the pattern is not as complex as that in *Hipparion mohavense.*

In the fragmentary upper tooth,[4] No. 12581 U. C. C., found at the same locality with the type of *Hipparion leptode*, the fossettes are quite narrow, but this character may not be emphasized more strongly in No. 12581 than in teeth of No. 27126.

The lower dentition and the anterior portion of the lower jaw are shown in figure 5. The incisors that are preserved have large pits with heavy deposits of cement. The lower canine is very small. The lower cheek-teeth are narrow and also heavily cemented. The metaconid-metastylid column is long anteroposteriorly, with a broad longitudinal furrow in the posterior premolars and in the molars. This groove deepens in the premolar series from P$\overline{2}$ to P$\overline{4}$ and remains deep in the molar teeth. The furrow is distinctly deeper and wider than in lower teeth of *Hipparion mohavense.* In the premolars the entoconid is long anteroposteriorly and its anterior end is pointed. In all the cheek-teeth, with the exception of M$\overline{3}$, the hypoconulid (of Osborn) projects distinctly beyond the inner wall of the entoconid. The outer walls of protoconid and hypoconid tend to be flattened. A small fold is present at the antero-external angle of the tooth except in P$\overline{2}$. In addition to this fold a strong external ridge at the anterior end of the hypoconid is present. This ridge is particularly prominent in P$\overline{4}$. In the premolars it projects directly outward, in the posterior molars outward and slightly forward.

*Relationship of No. 27126*—In both the type of *H. leptode,* No. 19414 U. C. C., and No. 27126 the lower tooth-crown is narrow and slender, with

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[4] J. C. Merriam, Univ. Calif. Publ. Bull. Dept. Geol., vol. 6, p. 263, figs. 32*a*, 32*b*, 1911.

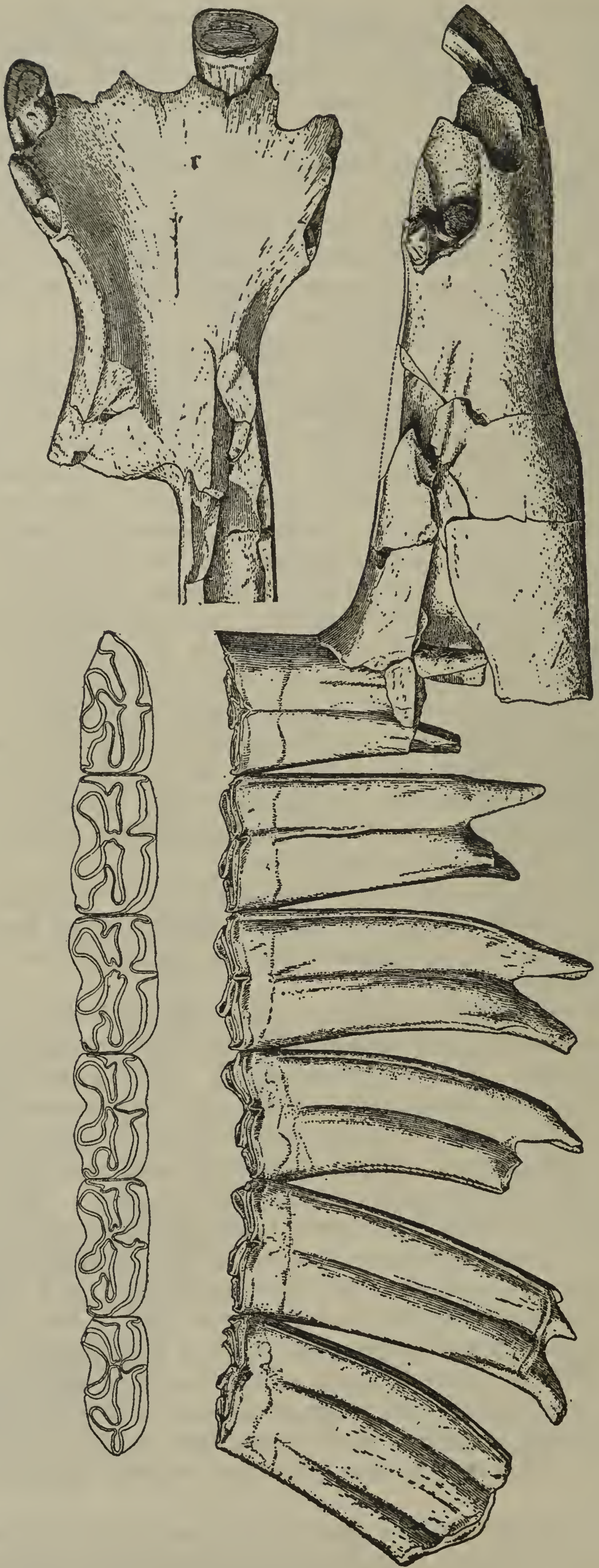

Fig. 5. *Hipparion (Neohipparion) leptode* Merriam. Mandibular fragment and lower dentition, No. 27126 U. C. C.; lateral and superior views, ×0.66. Thousand Creek Pliocene, Nevada.

the metaconid-metastylid column and inner furrow revealing similar characters. In both specimens, also, a strong external ridge is present on the hypoconid as well as at the anterior end of the protoconid. There appears little reason for doubting, therefore, the specific identity of the two forms. The lower tooth described by Merriam[5] as the type of this species was regarded as representing M$\overline{2}$. A comparison of the tooth with the complete set of molar teeth in No. 27126 indicates that No. 19414 resembles M$\overline{3}$ rather than M$\overline{2}$ in certain of its characters, as for example in narrowness of the tooth-crown, in posterior elongation of the hypoconulid, and in, perhaps, the attitude of the external ridge of the hypoconid. It appears quite possible, therefore, that the type of *H. leptode* is a third lower molar.

The *Hipparion* species of the Ricardo horizon have uniformly smaller and less elongated protocones. The nearest approach among the Great Basin hipparions is in the Rattlesnake Pliocene forms, among which compressed and elongated protocones predominate. *H. sinclairii* of the Rattlesnake may have a large and strongly compressed protocone, but teeth referred to this species may be smaller than No. 27126. Several specimens from the Rattlesnake fauna referred to *H. occidentale* have dimensions comparable to those of No. 27126 and show compression of protocone combined with complication of enamel folds. Among these specimens are lower teeth that clearly bear a close resemblance to comparable teeth in *H. leptode.* It seems not improbable that *Hipparion leptode, H. sinclairii* and *H. occidentale* represent a group of very closely related species.

*Measurements (in millimeters) of dentition, No. 27126*

| | |
|---|---|
| I$\underline{1}$, greatest transverse diameter | 15.4 |
| I$\underline{2}$?, greatest transverse diameter | 16.6 |
| $\underline{C}$, greatest anteroposterior diameter | 4.7 |
| P$\underline{2}$, anteroposterior diameter | 27.1 |
| P$\underline{2}$, greatest transverse diameter | 20.7 |
| P$\underline{3}$, anteroposterior diameter | 24.2 |
| P$\underline{3}$, greatest transverse diameter | 23.1 |
| P$\underline{4}$, anteroposterior diameter | 22.8 |
| P$\underline{4}$, greatest transverse diameter | 22.5 |
| M$\underline{1}$, anteroposterior diameter | 23. |
| M$\underline{1}$, greatest transverse diameter | 22.6 |
| M$\underline{2}$, anteroposterior diameter | 22.3 |
| M$\underline{2}$, greatest transverse diameter | 21. |
| M$\underline{3}$, anteroposterior diameter | 22.7 |
| M$\underline{3}$, transverse diameter | 17.3 |
| Length of upper cheek-tooth series, P$\underline{2}$ to M$\underline{3}$ | 141. |
| I$\overline{1}$, transverse diameter | 14.3 |
| I$\overline{3}$, greatest diameter | 12.1 |
| $\overline{C}$, anteroposterior diameter | 4.1 |
| P$\overline{2}$, anteroposterior diameter | 24.8 |
| P$\overline{2}$, greatest transverse diameter | 13. |
| P$\overline{3}$, anteroposterior diameter | 23.8 |
| P$\overline{3}$, greatest transverse diameter | 14.5 |
| P$\overline{4}$, anteroposterior diameter | 23.7 |
| P$\overline{4}$, greatest transverse diameter | 14.4 |
| M$\overline{1}$, anteroposterior diameter | 22.8 |
| M$\overline{1}$, greatest transverse diameter | 13. |
| M$\overline{2}$, anteroposterior diameter | 24.2 |
| M$\overline{2}$, greatest transverse diameter | 12.6 |
| M$\overline{3}$, anteroposterior diameter | 25. |
| M$\overline{3}$, greatest transverse diameter | 10.4 |
| Length of lower cheek-tooth series, P$\overline{2}$ to M$\overline{3}$ | 144.3 |

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[5] J. C. Merriam, Univ. Calif. Publ. Bull. Dept. Geol., vol. 9, pp. 3–5, fig. 3, 1915.

Associated with the skull and lower jaw of No. 27126 are the remains of the two front feet. An incomplete specimen representing the right front foot of *Hipparion leptode* is shown in Plate I, figures 1 and 2. Unfortunately metacarpals II and III are not entirely preserved, but the fragments which remain indicate conclusively that the elements flanking metacarpal III were completely formed and carried side toes. One of the lateral digits occurs in the collection. It is shown in Plate I, figure 4, as representing the fourth digit of the right front foot.[6]

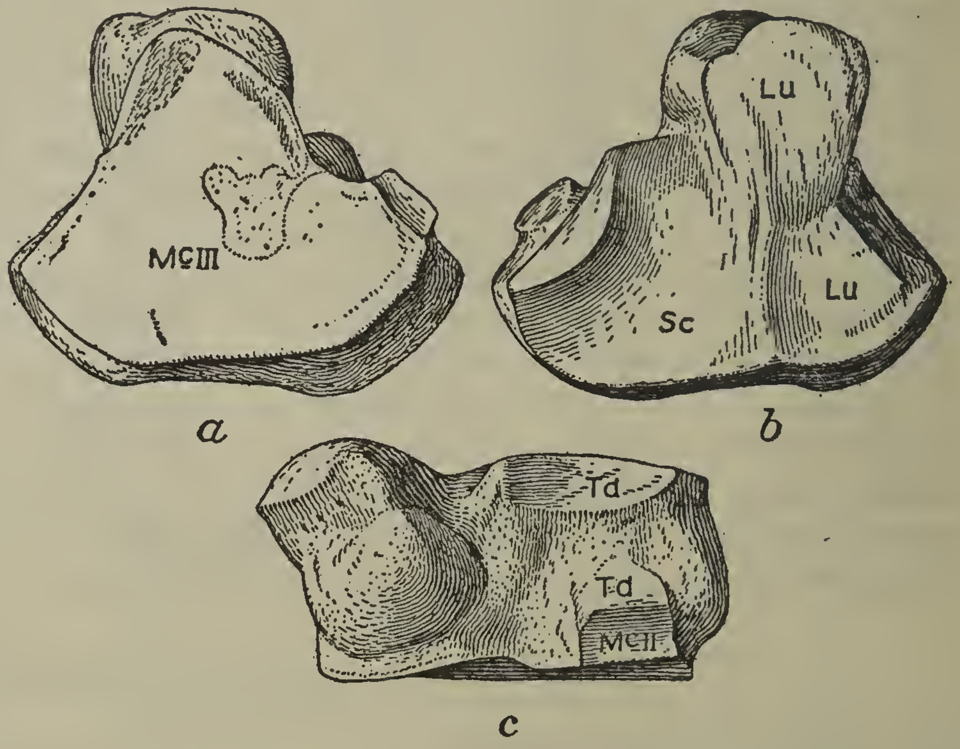

Fig. 6. *Hipparion* (*Neohipparion*) *leptode* Merriam. Left magnum, No. 27126 U. C. C.; ×1.0. *a*, distal view; *b*, proximal view; *c*, inner view, showing facets McIII for metacarpal III, Sc, for scaphoid, Lu, for lunar, Td, for trapezoid, and McII for metacarpal II. Thousand Creek Pliocene, Nevada.

The carpus includes the magnum, lunar, pisiform and cuneiform. In the magnum (fig. 6*a*, *b*, *c*) the anterior portion of the articulating surface for the scaphoid is relatively broad anteroposteriorly. The posterior end of the lunar facet does not bend downward as much as in *Equus*. The opposite surface for the metapodial, as shown in figure 6*c*, has a somewhat different shape from that in *Equus*. The upper anterior facet for the trapezoid is noticeably concave in its longest diameter. No posterior facet for the trapezoid is present. In anterior view the lunar is seen to be slightly less wedge-shaped than in *Equus*, and the element is less constricted through its middle than in the latter genus. The facet for the unciform is relatively broader than in *Equus*. The posterior knob or process above the facet for

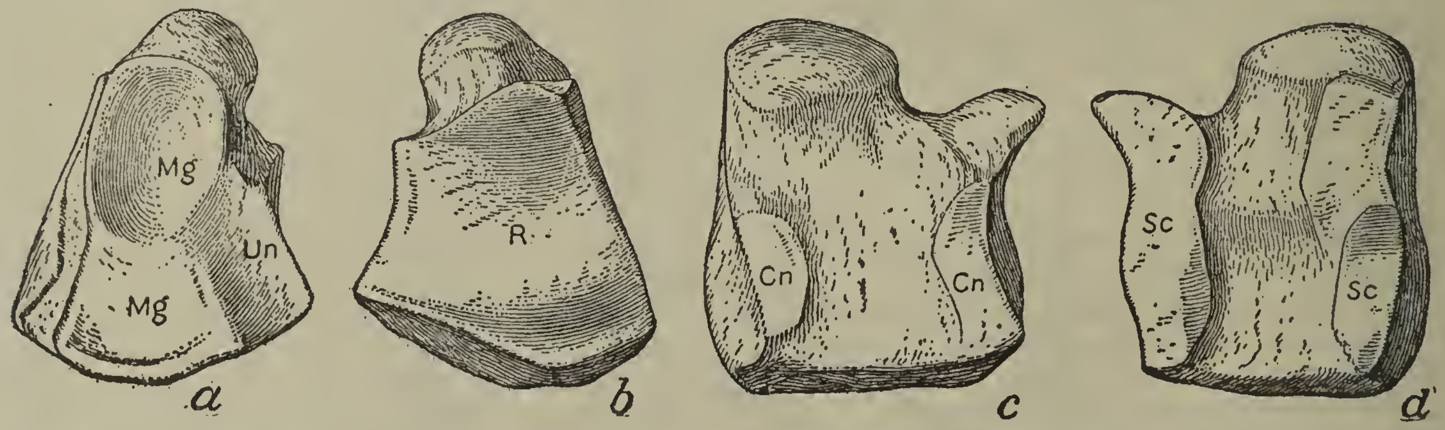

Fig. 7. *Hipparion* (*Neohipparion*) *leptode* Merriam. Right lunar, No. 27126 U. C. C.; ×1.0. *a*, distal view; *b*, proximal view; *c*, outer view; *d*, inner view, showing facets Mg, for magnum, Un, for unciform, R, for radius, Cn, for cuneiform, and Sc, for scaphoid. Thousand Creek Pliocene, Nevada.

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[6] The possibility that the digit is the second of the left front foot does not appear, however, to be entirely eliminated.

the magnum is less prominently developed in the Pliocene form than in *Equus*. The cuneiform and pisiform are shown in figure 8.

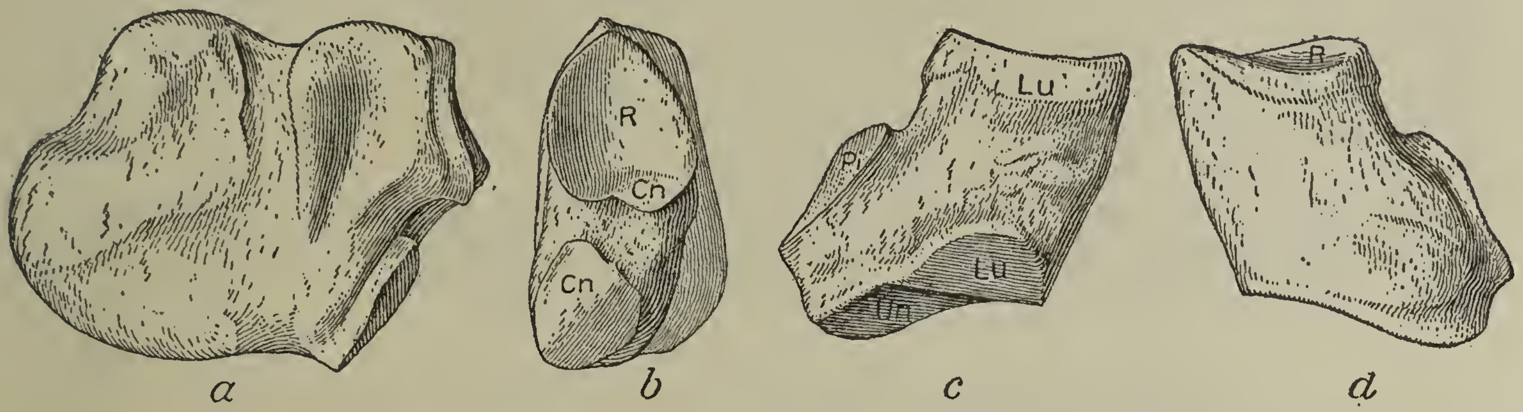
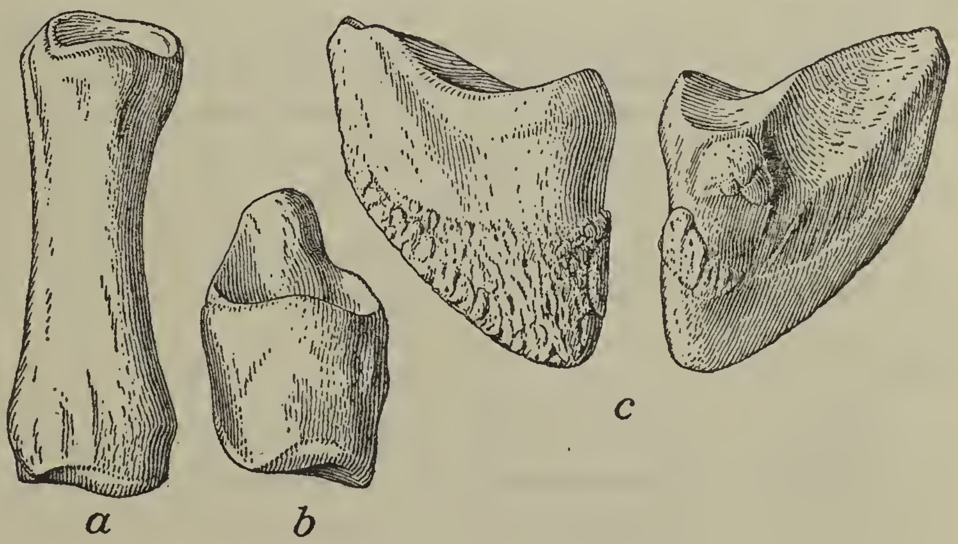


Fig. 8. *Hipparion (Neohipparion) leptode* Merriam. *a* and *b*, right pisiform, views of outer side and articulating end showing facets R, for radius, *Cn*, for cuneiform. *c* and *d*, left cuneiform, outer and inner views showing facets Lu, for lunar, Un, for unciform, and Pi, for pisiform; ×1.0. No. 27126 U. C. C. Thousand Creek Pliocene, Nevada.

Metacarpal III is a slightly longer but decidedly stouter element than that of *Hipparion whitneyi*. At the proximal end the plane of the unciform surface makes an angle of 46° with that of the magnum facet. The shaft increases slightly in width downward from the end of the proximal fourth. In broadness of shaft this element differs somewhat from that in *H. whitneyi*. On the posterior face of the distal articulating surface the lower limits of contact between this surface and the sesamoid bones are plainly marked. The median keel in this region is sharp, while in front it becomes rounded.

The side elements, metacarpals II and IV, are completely developed although not entirely preserved in No. 27126. In *H. whitneyi* the shaft of the lateral metapodials becomes of splint-like proportions in the lower three-quarters of its total length, although the lower end expands and supports a lateral digit. In *H. leptode* the shaft of the lateral metapodials is more strongly developed, thus reflecting in this respect also the greater robustness of the foot as contrasted with that of the Great Plains species. While no facet is recognized at the proximal end of metacarpal II in No. 27126 suggesting the presence of a rudiment of metacarpal I, a relatively large facet is present on the fourth metapodial for a rudimentary fifth element.

Fig. 9. *Hipparion (Neohipparion) leptode* Merriam. Lateral digit of manus, No. 27126 U. C. C.; ×1.0. *a*, phalanx I, superior view; *b*, phalanx II, superior view; *c*, phalanx III, superior and inferior views. Thousand Creek Pliocene, Nevada.



The single lateral digit consisting of three phalanges present in the collection has essentially the characters seen in *H. whitneyi*. The individual elements are distinctly larger than in the latter species. In phalanx II the outer half of the posterior lower margin is drawn backward to form the border of a distinct process. In phalanx III the outer portion of the segment is carried backward to form a thin plate of bone lying below and in back of the proximal articulating surface. Beneath the proximal articulation the ventral surface is perforated by several vascular foramina. The anterior portion of this surface is convex transversely. The superior surface is decidedly rugose along the anterior border.

Excepting size, the phalanges of the median digit again show resemblance to the comparable elements in *H. whitneyi*. The apex of phalanx III is cleft, although relatively not as deeply as in the latter form.

*Measurements (in millimeters) of foot elements, No. 27126*

| | |
|---|---|
| Carpals— | |
| Magnum, greatest transverse diameter | 35.3 |
| Magnum, greatest anteroposterior diameter | 30.8 |
| Magnum, greatest dorso-ventral diameter | 18.9 |
| Lunar, greatest transverse diameter | 24. |
| Lunar, greatest anteroposterior diameter | 27.8 |
| Lunar, greatest dorso-ventral diameter | 25.8 |
| Cuneiform, dorso-ventral diameter | 21.7 |
| Pisiform, greatest length through middle | 38.7 |
| Metacarpal II— | |
| Greatest diameter of proximal end | 17.8 |
| Greatest diameter of distal articulating end | 18.2 |
| Transverse diameter of distal articulation | 9.3 |
| Metacarpal III— | |
| Greatest length | 228.2 |
| Width of proximal end | 38.5 |
| Anteroposterior diameter of proximal end | 28.2 |
| Transverse diameter at middle of shaft | 25.9 |
| Anteroposterior diameter at middle of shaft | 21.5 |
| Transverse diameter of distal end | 34.7 |
| Anteroposterior diameter through median keel | 29.6 |
| Metacarpal IV— | |
| Greatest diameter of proximal end | 18. |
| Lateral digit— | |
| Phalanx I, greatest length | 39.1 |
| Phalanx II, greatest transverse diameter of proximal end | 13. |
| Phalanx I, greatest dorso-ventral diameter of proximal end | 18.2 |
| Phalanx I, greatest transverse diameter of distal end | 13. |
| Phalanx II, greatest length through middle | 15.7 |
| Phalanx II, greatest width | 14.8 |
| Phalanx III, greatest width | 21.2 |
| Phalanx III, dorso-ventral diameter | 15.5 |
| Phalanx III, length | 30.5 |
| Digit III— | |
| Phalanx I, greatest length | 67. |
| Phalanx I, greatest depth of proximal end | 29.3 |
| Phalanx I, greatest width of proximal end | 38. |
| Phalanx II, greatest length | 38.7 |
| Phalanx II, width of proximal end | 37.4 |
| Phalanx III, greatest length | 60.8 |
| Phalanx III, greatest width | 56.7 |
| Phalanx III, greatest dorso-ventral diameter | 34. |

### Hipparion leptode Merriam or H. occidentale Leidy?

A single upper cheek-tooth, No. 22380 (fig. 10), represents a *Hipparion* form similar in size to No. 27126. The occlusal surface exhibits a large and elongated protocone and the enamel borders of the fossettes show slightly more complicated folds than in No. 27126. A short spur of enamel suggests a pli caballin. While the protocone is comparable in length to that in teeth of No. 27126, it is noticeably wider transversely than in the latter specimen.

No. 22380 may represent *H. leptode* or may be referred provisionally to *H. occidentale.*

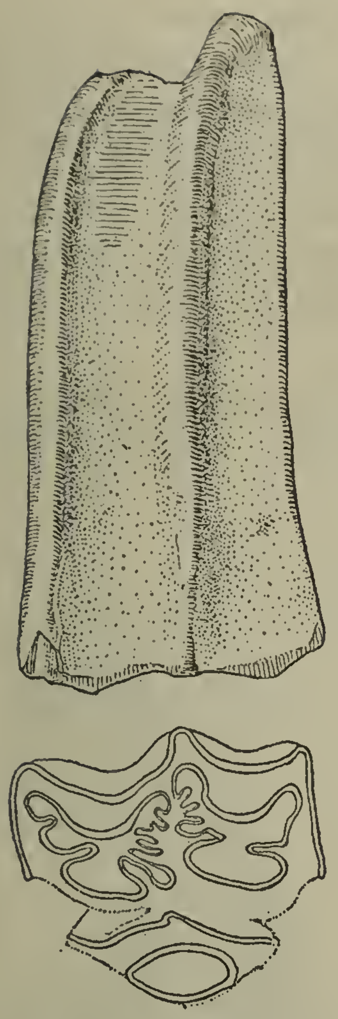


Fig. 10. *Hipparion leptode* Merriam or *H. occidentale* Leidy?. Upper cheek-tooth, No. 22380 U. C. C.; lateral and occlusal views, ×1.0. Thousand Creek Pliocene, Nevada.

*Measurements (in millimeters) of No. 22380*

| | |
|---|---|
| Anteroposterior diameter | 24.3 |
| Transverse diameter | 22.3 |
| Anteroposterior diameter of protocone | 9.8 |

### Teleoceras fossiger (Cope)

Rhinocerotid remains are abundantly represented in the collections from Thousand Creek, but the material usually represents fragmentary and incomplete parts of the skeleton.

A fragmentary skull and lower jaw with dentition, No. 22901, furnishes perhaps the most satisfactory evidence on which determination of the Thousand Creek type can be based. Unfortunately only a small portion of the face and a part of the zygomatic arch remain in the skull of this form (Plate 2), but the cheek teeth are fairly well preserved. The jugal is heavy and deepens posteriorly. The antorbital foramen is situated at a relatively short distance in front of the maxillo-jugal suture and lies above the anterior end of $\underline{P3}$. The nasals, shown in figure 11*a*, *b*, *c*, are slender and narrow anteriorly. While similar in character to those of *Teleoceras* described by Matthew,[7] the nasals in the Thousand Creek form do not possess a distinctly rugose upper surface of the anterior end.

The upper dentition in No. 22901 consists of $\underline{P2}$ to $\underline{M3}$. The molar series is noticeably longer than the premolar series. In the premolars and in the first molar the pre- and postfossettes are closed and the prefossette is distinctly larger than the postfossette. In $\underline{M2}$ well-developed crochet and antecrochet are present, but the crista seems to be absent.

Only the anterior portion of the lower jaw is present, but the lower dentition is well preserved (see plate 3). The symphysis reaches back to a point opposite the middle of $\overline{P4}$. A mental foramen is situated close to the inferior border and below the middle of $\overline{P4}$. The diastema between the incisor tusk and the anterior premolar is very short and the side of the jaw in this region is deeply concave. The distance between the tusks is also very short. Very small, shallow depressions are present on the anterior border of the symphysis.

---

[7] W. D. Matthew, Bull. Amer. Mus. Nat. Hist., vol. 38, p. 202, fig. 9c, 1919.

The lower tusk is large and sweeps upward in a decided curve, the tip reaching a point well above the level of the tooth-row. The worn surface of this tooth is well shown in Plate 3. The lower cheek teeth include $P\overline{3}$ to $M\overline{3}$, with a remnant of a root representing probably a rudimentary $P\overline{2}$.

A number of foot-bones in the collections from Thousand Creek belong without much doubt to the short-footed *Teleoceras*. The metapodials exhibit characters very close to those seen in comparable elements of the Great Plains species.

The rhinocerotid types of the Ricardo deposits, Mohave Desert, California, are clearly distinguishable from the Thousand Creek genus. These forms have been described as belonging to *Aphelops* and to *Peraceras?*. The lower jaw from the Ricardo which has been provisionally referred to *Peraceras*[8] differs decidedly from *Teleoceras* in the greatly shortened symphyseal region and in the absence of a lower tusk. The presence of these forms in the Ricardo fauna and the absence of *Teleoceras* may be taken as a further indication of the faunal difference which exists between the Ricardo and Thousand Creek horizons.

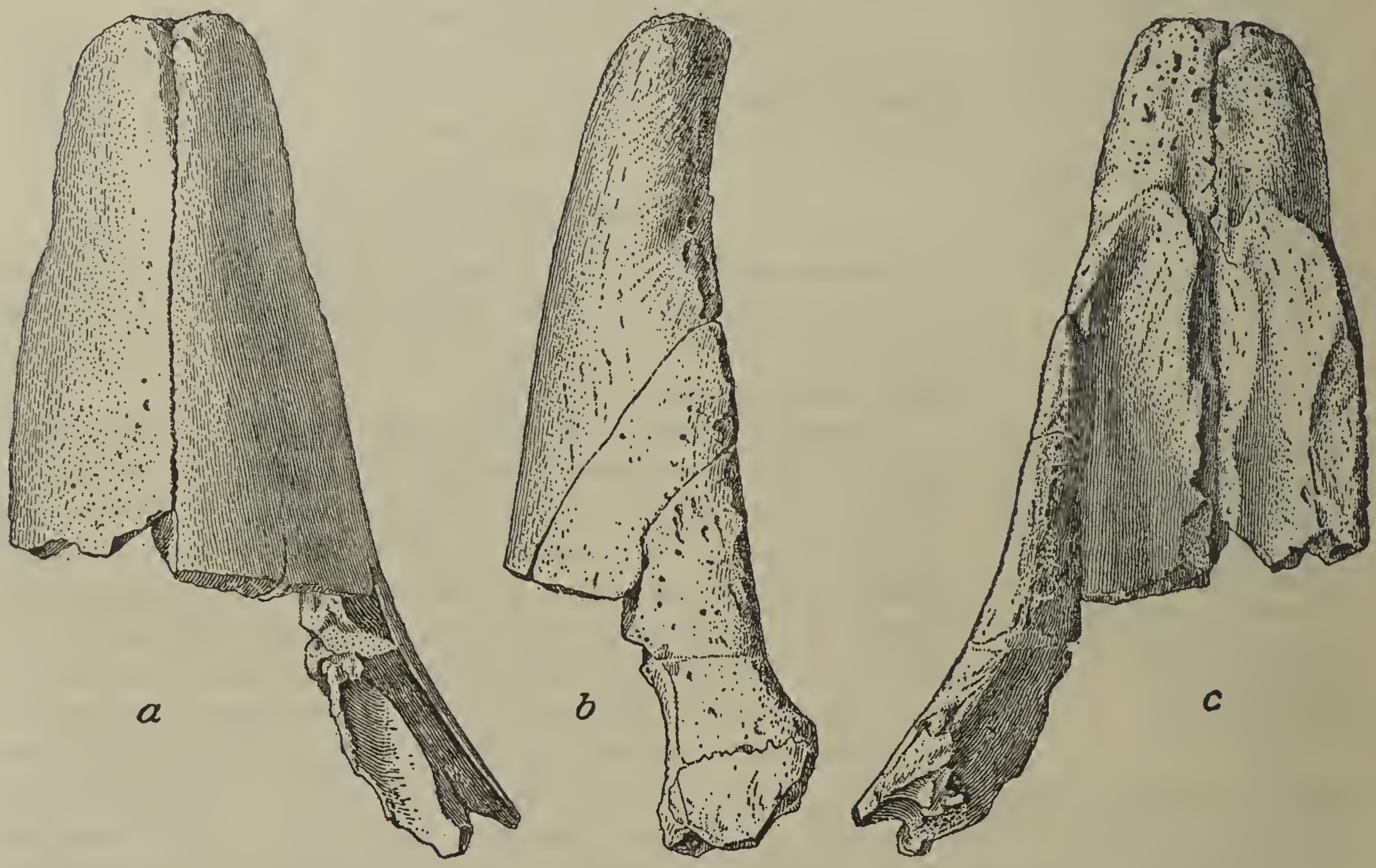


Fig. 11. *Teleoceras fossiger* (Cope). Nasals, No. 22901 U. C. C.; ×0.50. *a*, superior, *b*, lateral, *c*, inferior view. Thousand Creek Pliocene, Nevada.

It appears quite possible that several distinct rhinocerotid genera occur in the Rattlesnake fauna. Metapodials of short-footed forms having considerable resemblance to those of *Teleoceras fossiger* are known from the Rattlesnake deposits.

---

[8] C. Stock and E. L. Furlong, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 16, pp. 50–51, pl. 10, 1926.

*Measurements (in millimeters) of dentition, No. 22901*

| | |
|---|---|
| $P\underline{2}$, anteroposterior diameter | 30.9 |
| $P\underline{2}$, transverse diameter | 35. |
| $P\underline{4}$, anteroposterior diameter | 47.2 |
| $P\underline{4}$, transverse diameter | 64.3 |
| $M\underline{1}$, anteroposterior diameter | 51.9 |
| $M\underline{1}$, transverse diameter | 65.4 |
| Length from anterior end of $P\underline{2}$ to posterior end of $M\underline{1}$ | 146.3 |
| Lower tusk, greatest anteroposterior diameter at base of worn surface | 28.4 |
| Lower tusk, greatest transverse diameter at base of worn surface | 56.4 |
| $P\overline{3}$, anteroposterior diameter | *a*34. |
| $P\overline{3}$, transverse diameter | 28.2 |
| $P\overline{4}$, anteroposterior diameter | 40.9 |
| $P\overline{4}$, transverse diameter | 29.3 |
| $M\overline{1}$, anteroposterior diameter | 42.6 |
| $M\overline{1}$, transverse diameter | *a*29.2 |
| $M\overline{2}$, anteroposterior diameter | *a*48.6 |
| $M\overline{2}$, transverse diameter | .... |
| $M\overline{3}$, anteroposterior diameter | 52. |
| $M\overline{3}$, transverse diameter | 30. |
| Length from anterior end of $P\overline{3}$ to posterior end of $M\overline{3}$ | *a*214. |

In measuring the individual cheek-teeth the greatest diameters have been taken.
*a*, approximate.

### Prosthennops sp.

Little additional peccary material has been obtained since the original description of the fragments of the dentition from the Thousand Creek beds.[9]

Three premolar teeth and a portion of the maxillary, No. 30040 Mus. Pale. Univ. Calif. Coll., are shown in figure 12. The specimens were found at Locality 2744 U. C. Mus. Pale. The teeth represent $P\underline{2}$ and $P\underline{3}$ of the right side and $P\underline{4}$ of the left.

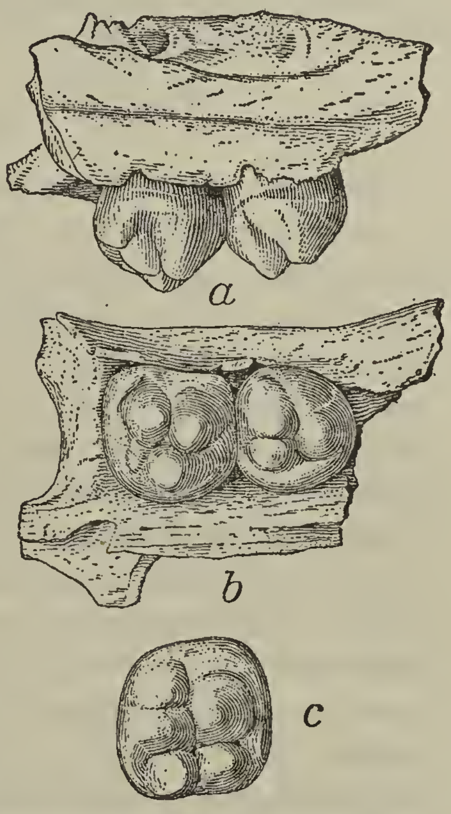


Fig. 12. *Prosthennops* sp. Maxillary fragment with $P\underline{2}$, $P\underline{3}$, and $P\underline{4}$, No. 30040 U. C. C.; ×1.0. *a*, lateral view, *b*, occlusal view, *c*, occlusal view of $P\underline{4}$. Thousand Creek Pliocene, Nevada.

$P\underline{2}$ is a relatively large tooth, rudely triangular in shape. Two cusps are present on the outer side of the crown and are separated by a cleft which extends outward, backward and upward. An inner posterior cusp or incipient cusp is also present and a cingulum extends along the inner side. In the presence of three cusps this tooth is apparently like that of *Prosthennops serus* (Cope) from the Upper Snake Creek. In possessing a greater number of cusps $P\underline{2}$ differs from No. 11876 U. C. C., a tooth described from the Thousand Creek beds by Merriam[10] and provisionally regarded as $P\underline{2}$.

$P\underline{3}$ has three principal cusps of which the inner anterior one is the largest. The outer anterior cusp is larger than the outer posterior cusp. A cuspule of minor size lies in the region to the inner side of the outer posterior cusp and behind the inner anterior cusp. The posterior cingulum is well developed. $P\underline{3}$ resembles in shape, and in a measure also in the arrangement of the tubercles the tooth, No. 11876, provisionally regarded by Merriam[11] as $P\underline{3}$ of *Prosthennops* from the Thousand Creek.

[9] J. C. Merriam, Univ. Calif. Publ. Bull. Dept. Geol., vol. 6, pp. 272–275, figs. 52 to 53a, b, c, 1911.

[10] J. C. Merriam, *op. cit.*, fig. 53*a*, p. 273, 1911.

[11] J. C. Merriam, *op. cit.*, fig. 53*b*, p. 273, 1911.

In *P. serus* from the Snake Creek, P$\underline{3}$, according to Matthew, has four main cusps.

The crown of P$\underline{4}$ (fig. 12*c*), accompanying the maxillary fragment at Locality 2744 represents the tooth of the left side. This tooth is quadrate in shape and possesses an anterior transverse row of two cusps and a posterior transverse row of three cusps. The increase to three cusps in the posterior row is due apparently to a division of the inner posterior cusp into two parts. A cingulum is present at the antero-internal corner and likewise at the postero-external corner of the tooth.

The maxillary fragment in No. 30040 U. C. C. includes small portions of the palate and face. The palatal portion is traversed by a canal. The facial portion exhibits the furrow or depression leading to the infraorbital foramen. In this depression and at a point above the anterior end of P$\underline{3}$ is the opening of a nutrient canal leading into the root region of the anterior premolars.

*Measurements (in millimeters) of No. 30040 U. C. C.*

| | |
|---|---|
| P$\underline{2}$, greatest anteroposterior diameter | 9.3 |
| P$\underline{2}$, greatest transverse diameter | 10. |
| P$\underline{3}$, greatest anteroposterior diameter | 10.9 |
| P$\underline{3}$, greatest transverse diameter | 11.1 |
| P$\underline{4}$, greatest anteroposterior diameter | 12.2 |
| P$\underline{4}$, greatest transverse diameter | 12.5 |

## Sphenophalos nevadanus Merriam

Several specimens representing the bases of horn-cores of *Sphenophalos nevadanus* illustrate the typical characters of this species. Among these No. 22427 illustrates better than any specimen found up to this time the spreading type of horn with wedge-shaped cross-section, described in an earlier publication.[12] Unfortunately none of the known horn-cores show the summit. Nearly all of the specimens are broken off in much the same way and at nearly the same point, which suggests that there may have been a zone of weakness in this region, or that the bone above this point was of a somewhat different nature.

A small specimen, No. 22429 (fig. 13), less than half the size of the typical adult *Sphenophalos nevadanus,* shows a horn-core with a transversely flattened cross-section and a slight upward flare. At a distance above the base, somewhat less than twice the greatest width of this horn-corn, the upper region is noticeably constricted by an outer or lateral longitudinal groove beginning near the base of the horn and by a faint concavity of the upper end of the median side. The cross-section of the horn at this point is dumb-bell-like and the contour of the surface suggests a division into two terminal spikes or points of approximately equal size at a short distance above this section. There is a slight element of twist in this specimen which bends the anterior portion of the horn-core laterally or outward as in *Sphenophalos nevadanus.*

A third specimen, No. 22430 (fig. 14), represents a still younger animal with horn-core not more than half the size of that in No. 22429. In the smallest specimen the complete, strongly compressed, band-like horn-core has a length not more than one and one-half times its greatest width and terminates in two approximately equal points or spikes. The horn-core is slightly twisted and apparently the anterior spike is twisted outward.

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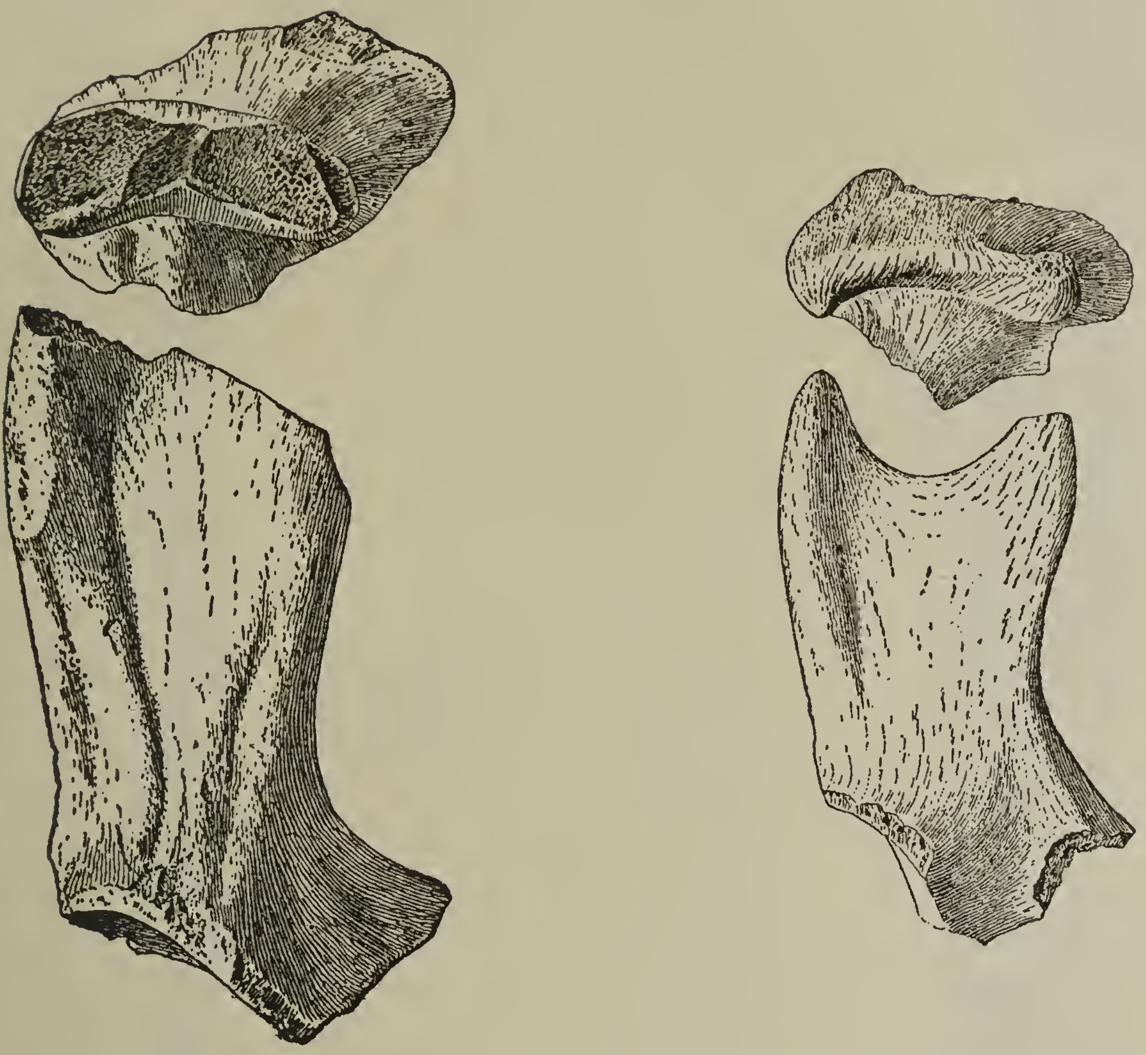
[12] J. C. Merriam, Univ. Calif. Publ. Bull. Dept. Geol., vol. 5, p. 326, 1909; *ibid*, vol. 6, p. 286, 1911.



13 14

Figs. 13 and 14. *Sphenophalos nevadanus* Merriam. Horn-cores; ×1.0. Fig. 13, No. 22429 U. C. C.; fig. 14, No. 22430 U. C. C. Thousand Creek Pliocene, Nevada.

While the available material is insufficient to furnish full proof, it is certainly strongly suggested that the smaller specimens, Nos. 22430 and 22429, show a transition series illustrating the origin of the horn-core in *Sphenophalos nevadanus*. The smallest specimen may represent a young individual of *S. nevadanus* or might be a distinct but smaller species. It is not improbable that complete horns of *S. nevadanus* will be found comparatively short and may terminate in two small spikes.

Although the characters of *Sphenophalos* seem still quite distinct from those of *Ilingoceros* and the smallest horn-core, No. 22430, with complete, bifurcated tip is presumably nearest to *Sphenophalos*, this horn-core offers a suggestion as to origin of a previously described,[13] bizarre horn-core (No. 11893) with bifurcated tip and spirally twisted shaft. This peculiar specimen has been referred to *Ilingoceros* on account of its spiral shaft. The divided tip is possibly a heritage from a common ancestor of both *Sphenophalos* and *Ilingoceros*.

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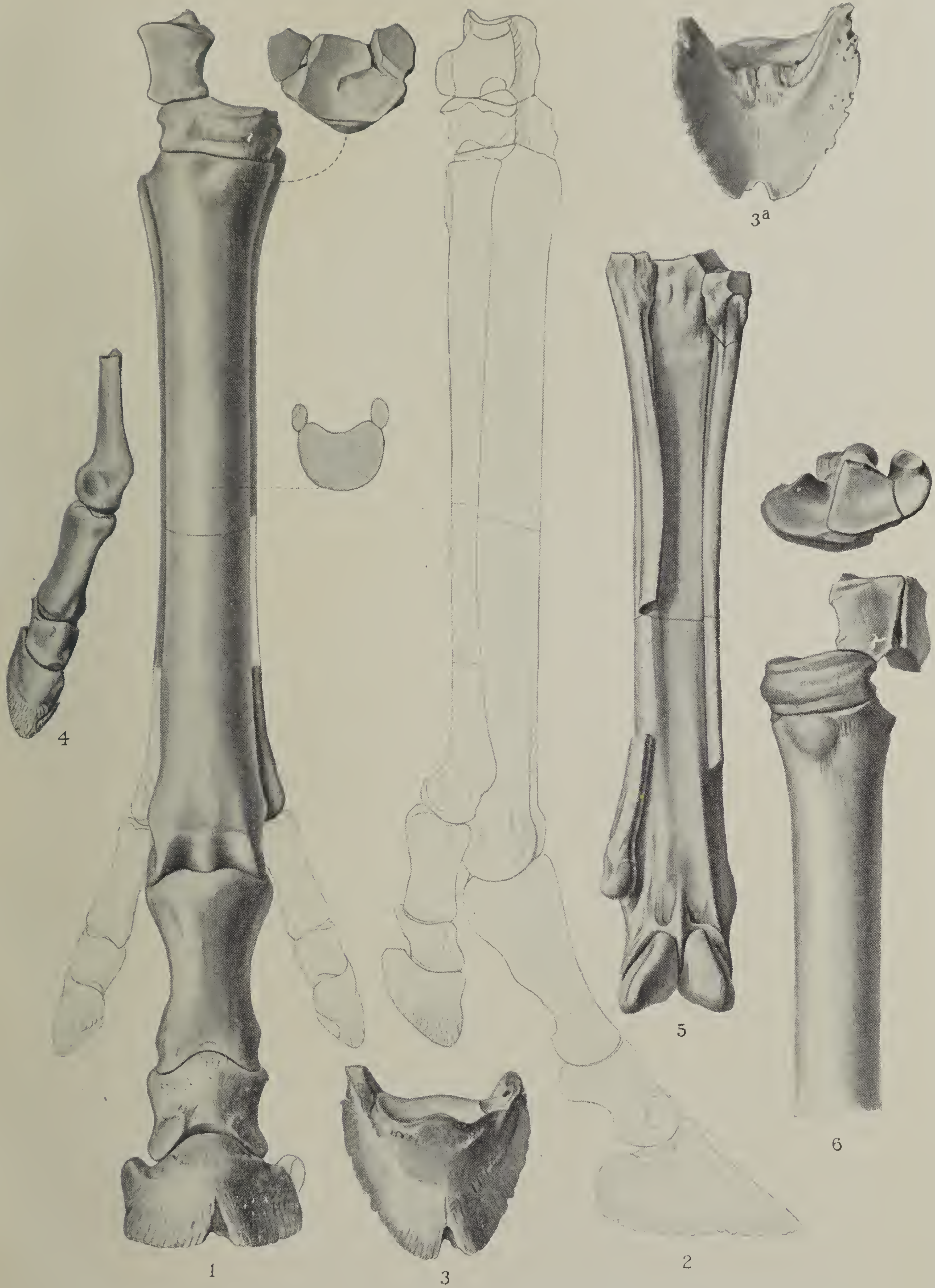
[13] J. C. Merriam, Univ. Calif. Publ. Bull. Dept. Geol., vol. 6, p. 293, figs. 73*a*, 73*b*, 1911.



*Hipparion (Neohipparion) leptode* Merriam. Front foot elements, No. 27126 University of California Collection. Thousand Creek Pliocene, Nevada. All figures ×0.50.

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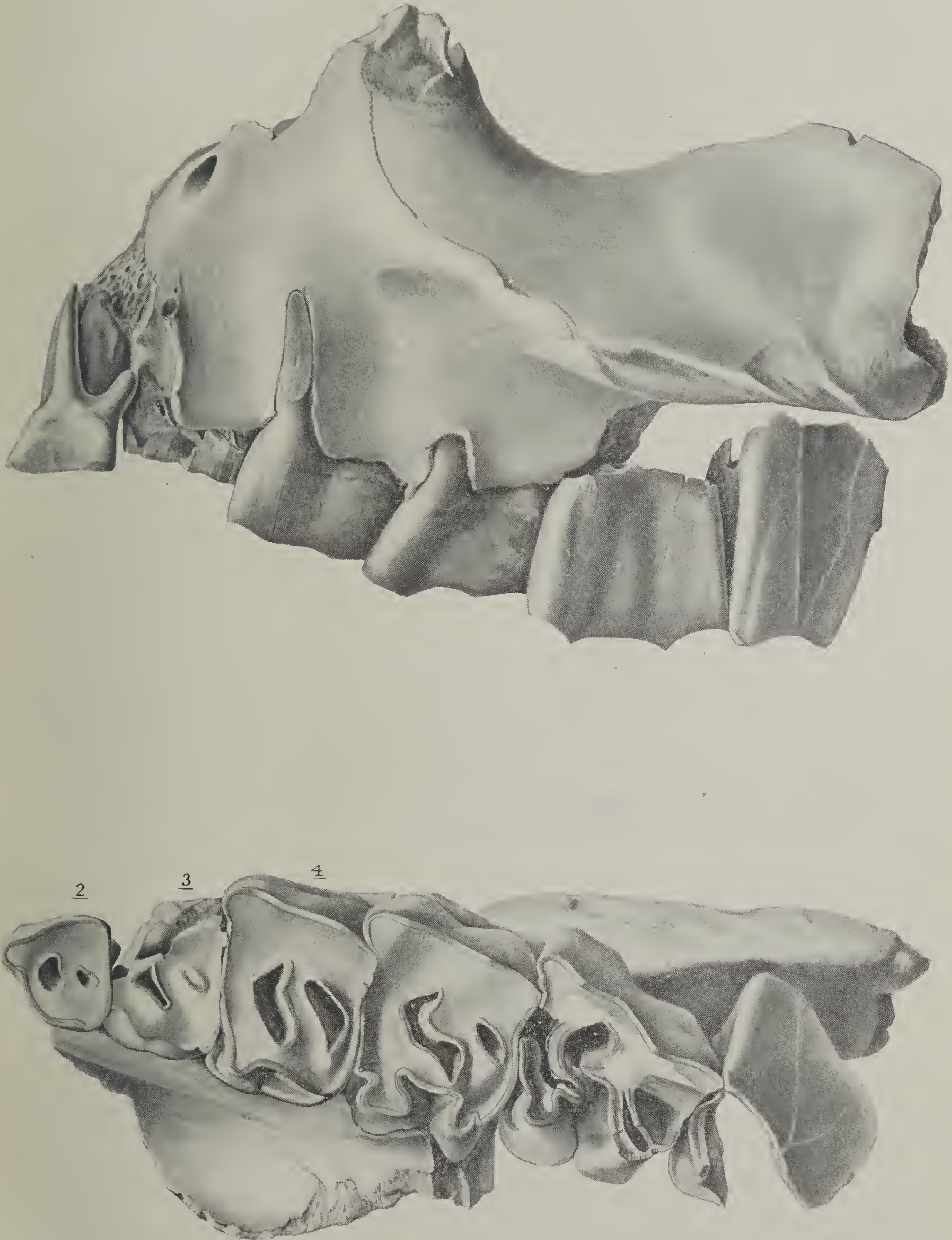

*Teleoceras fossiger* (Cope). Skull and superior dentition, No. 22901 University of California Collection. Thousand Creek Pliocene, Nevada. Lateral and inferior views, ×0.50.

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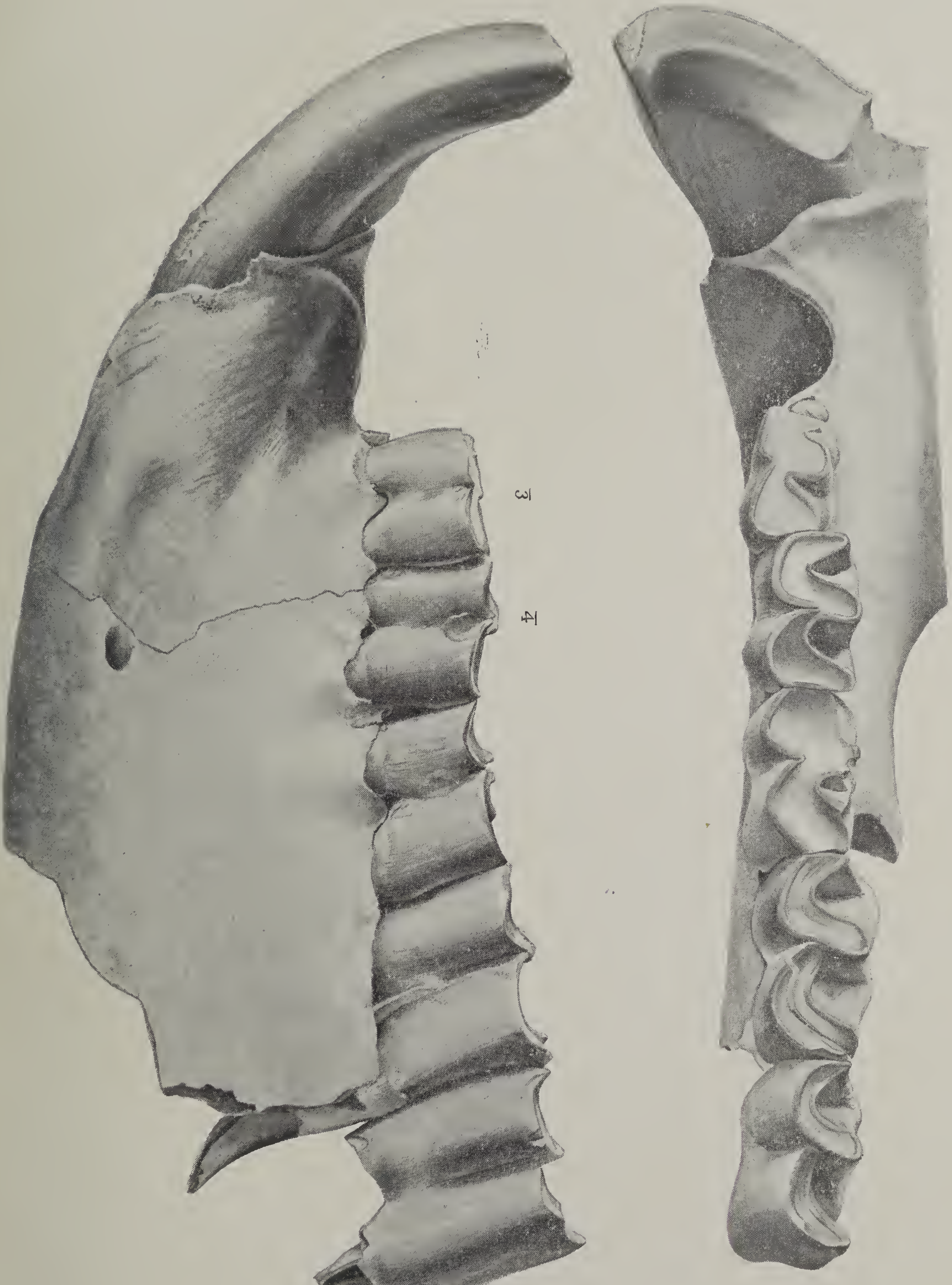

*Teleoceras fossiger* (Cope). Mandibular ramus and inferior dentition, No. 22901 University of California Collection. Thousand Creek Pliocene, Nevada. Lateral and superior views, ×0.50.

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## III

# A PECCARY FROM THE McKITTRICK PLEISTOCENE, CALIFORNIA

BY CHESTER STOCK

WITH SEVEN TEXT-FIGURES

# A PECCARY FROM THE McKITTRICK PLEISTOCENE, CALIFORNIA

By Chester Stock

The recent discovery of peccary material in the McKittrick asphalt deposits, during the excavations conducted for the California Institute of Technology by Charles H. Sternberg, adds another member to the list of mammals known from this locality. In view of the rather uncommon representation of peccaries in the Pleistocene of California a record of occurrence of these types at McKittrick seems particularly desirable.

### Platygonus near compressus Le Conte

The specimens collected by Mr. Sternberg are unfortunately quite fragmentary and consist of a portion of a mandibular ramus with milk and permanent teeth and a metapodial. The characters exhibited by this material clearly suggest the genus *Platygonus*.

In lower jaw fragment No. 1, Calif. Inst. Tech. Coll. Vert. Pale., the cheek-tooth series includes Dm$\bar{4}$, M$\bar{1}$ and M$\bar{2}$, with M$\bar{3}$ partly developed. The crowns of P$\bar{3}$ and P$\bar{4}$ are also present. These teeth occur in the jaw below the roots of Dm$\bar{4}$. The lower canine teeth are also present.

Dm$\bar{4}$ is much worn (fig. 1, 1*a*). The three transverse crests have been reduced to broad surfaces through attrition. The roots of the tooth are widely divergent. While P$\bar{3}$ and P$\bar{4}$ have not erupted in the specimen from McKittrick the crowns of these teeth are sufficiently developed to give the essential characters. P$\bar{3}$ (fig. 3) has an anterior crest which is rather wide anteroposteriorly and which has the summit cleft by a V-shaped valley sloping forward. A slight median ridge extends down the posterior surface of the crest and joins the posterior rim of the tooth. P$\bar{3}$ reaches its greatest transverse diameter behind the anterior crest. P$\bar{4}$ (fig. 5) is essentially an enlarged reproduction of P$\bar{3}$. The V-shaped valley at the summit of the anterior crest does not slope forward as in P$\bar{3}$. P$\bar{3}$ and P$\bar{4}$ in No. 1 are like the comparable teeth in *Platygonus compressus*[1] and in *P. leptorhinus*.

M$\bar{1}$ is somewhat broken but possesses the characters of crown seen in the comparable tooth of *Platygonus*. M$\bar{2}$ like M$\bar{1}$ has two transverse crests. The cross-crests are higher than in *Prosthennops*. Each crest is cleft at the summit by a V-shaped valley. The crests are connected in median line across the intervening valley, the connection extending upward to a point situated at approximately two-thirds the distance from the base to the top of the crown of the tooth. Short transverse cingula are present at the anterior and posterior ends of the tooth. In M$\bar{3}$ that portion of the tooth situated behind the second transverse crest is lacking. The anterior crest is larger and distinctly heavier than the second transverse crest.

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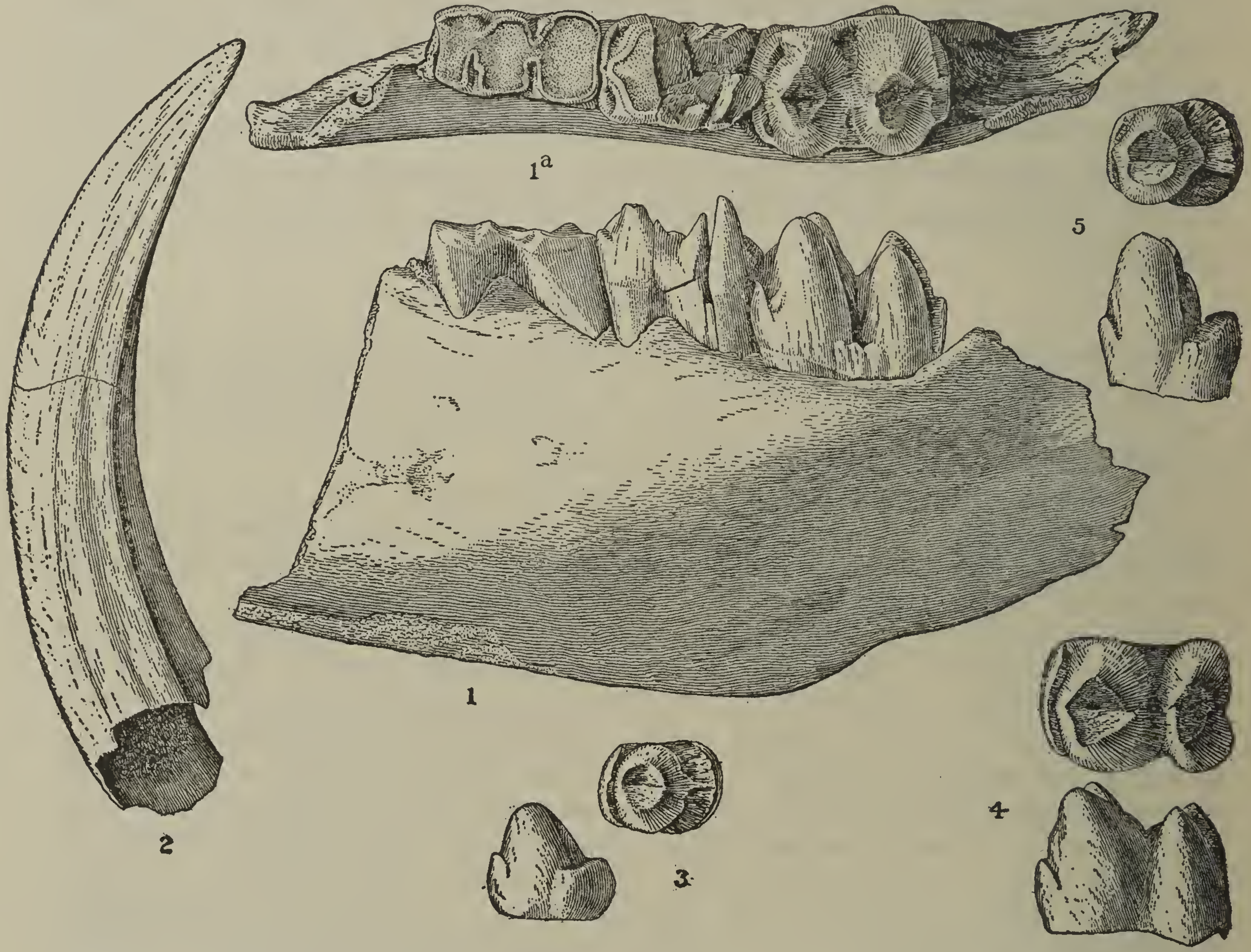
[1] In figures 5 and 6, Plate 21, of Hay's report on the Pleistocene mammals of Iowa, Ann. Rept. Iowa Geol. Surv., vol. 23, 1912, P$\bar{3}$ in the series of teeth of *Platygonus compressus* has been reversed, giving a posterior position to the transverse crest.

The single skeletal element available represents metacarpal III of the left manus (fig. 6). The metapodial No. 2, Calif. Inst. Tech. Coll. Vert. Pale., is slightly longer but distinctly more slender than the comparable element, No. 26639 U. C. C., of *Platygonus leptorhinus* Williston from the Pleistocene of Kansas. The latter specimen belongs, however, to an immature individual in which the distal epiphysis has not fused with the shaft. At the proximal end of No. 2 from McKittrick the trapezoid facet is somewhat smaller and the notch on the posterior border of the magnum facet is wider than in No. 26639 of *P. leptorhinus*.

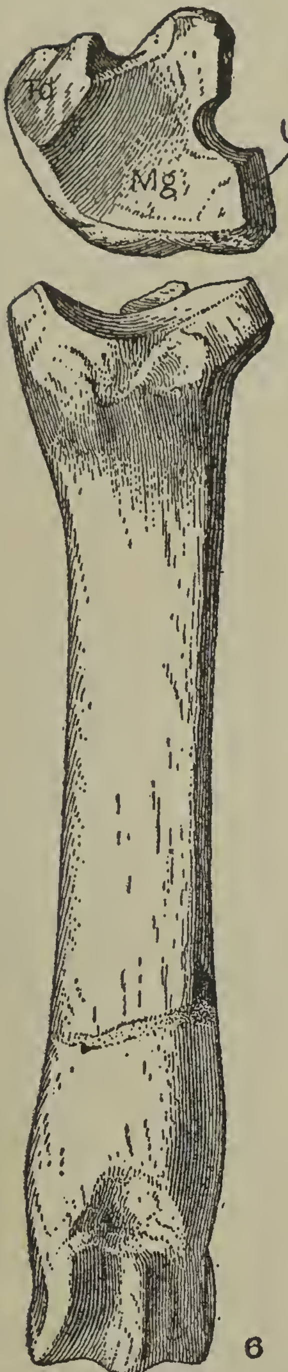


Figs. 1 to 5. *Platygonus* near *compressus* Le Conte. Mandibular fragment and lower dentition, No. 1 Calif. Inst. Tech. Coll. Vert. Pale.; ×1.0. Figs. 1, 1*a*, $\mathrm{Dm}\overline{4}$, $\mathrm{M}\overline{1}$ and $\mathrm{M}\overline{2}$, inner and superior views; fig. 2, lower canine; fig. 3, $\mathrm{P}\overline{3}$, inner and occlusal views; fig. 4, incomplete $\mathrm{M}\overline{3}$, inner and occlusal views; fig. 5, $\mathrm{P}\overline{4}$, inner and occlusal views. McKittrick Pleistocene, California.

Since the description of the *Platygonus* remains from Rancho La Brea,[2] another metapodial of a peccary has been found in the collections of the Los Angeles Museum. This specimen is recorded from Pit 16 of the Los Angeles Museum excavations at Rancho La Brea. The metapodial, No. 26004 L. A. Mus. Coll. is shown in figure 7. No 26004 represents apparently a third metacarpal of an adult individual, although the proximal end of the element is so abraded as to prohibit the identification of several of the facets characteristic of metacarpal III. The McKittrick metapodial is distinctly larger than No. 26004 from Rancho La Brea, and the shaft in the former specimen, as viewed from the outer side, is relatively narrower than that in the latter form.

---

[2] J. C. Merriam and C. Stock, *Notes on Peccary Remains from Rancho La Brea*, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 13, pp. 9–17, 1921.



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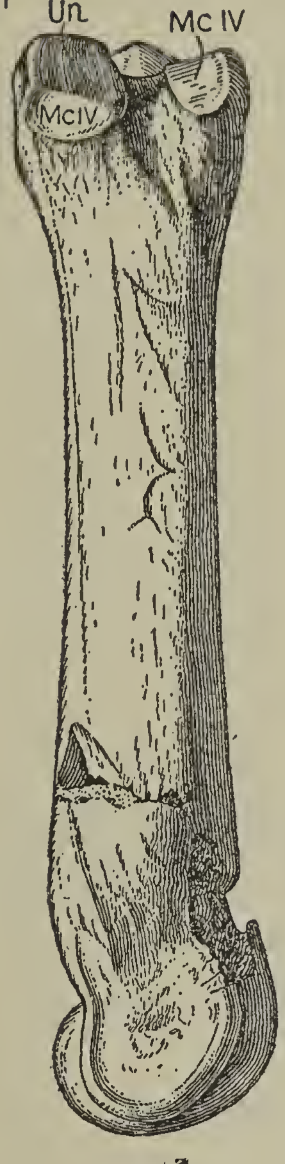

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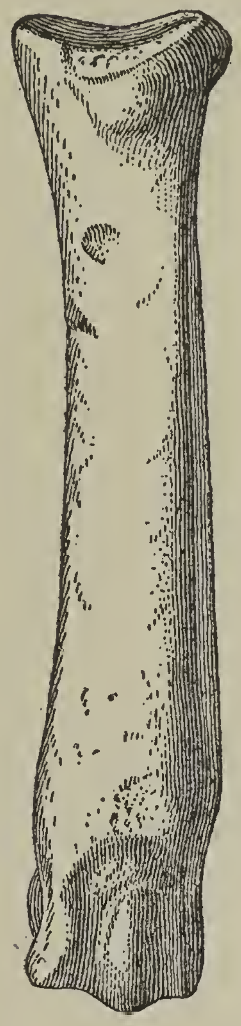

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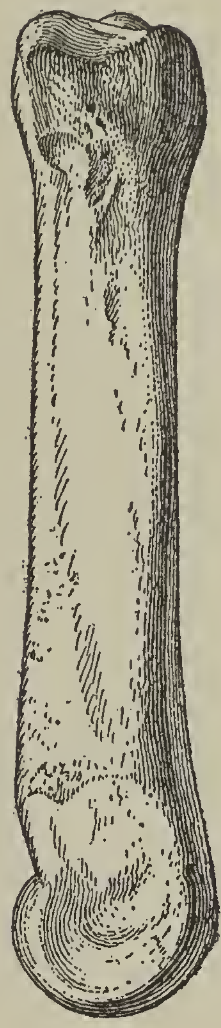

7a

Figs. 6, 6*a*. *Platygonus* near *compressus* Le Conte. Metacarpal III, No. 2 Calif. Inst. Tech. Coll. Vert. Pale. Fig. 6, anterior view and view of articulating end; fig. 6*a*, view of outer side; ×1.0. Facets Mg, for magnum, Td, for trapezoid, Un, for unciform, and McIV, for metacarpal IV. McKittrick Pleistocene, California.

Figs. 7, 7*a*. *Platygonus* possibly n. sp. or n. subsp. Metacarpal III?, No. 26004 L. A. Mus. Coll.; fig. 7, anterior view, fig. 7*a*, lateral view, ×1.0. Rancho La Brea Pleistocene, California.

*Measurements (in millimeters) of lower teeth, No. 1*

| | |
|---|---|
| Lower canine, anteroposterior diameter | 12. |
| Lower canine, transverse diameter | 10.3 |
| Dm$\overline{4}$, anteroposterior diameter | 17.1 |
| Dm$\overline{4}$, greatest transverse diameter | 9.1 |
| P$\overline{3}$, anteroposterior diameter | 12.2 |
| P$\overline{3}$, greatest transverse diameter | 9.4 |
| P$\overline{4}$, anteroposterior diameter | 13.6 |
| P$\overline{4}$, greatest transverse diameter | 10.7 |
| M$\overline{1}$, anteroposterior diameter (approximate) | 17.2 |
| M$\overline{1}$, greatest transverse diameter | .... |
| M$\overline{2}$, anteroposterior diameter | 20.9 |
| M$\overline{2}$, greatest transverse diameter | 13.7 |
| M$\overline{3}$, greatest transverse diameter | 13.9 |

*Measurements (in millimeters) of metacarpal III, No. 2*

| | |
|---|---|
| Greatest length (approximately) | 90.2 |
| Greatest transverse diameter of proximal end | 17.7 |
| Greatest anteroposterior diameter of proximal end | 19.6 |
| Transverse diameter of shaft at middle | 11.6 |
| Anteroposterior diameter of shaft at middle | 11.9 |
| Anteroposterior diameter through distal keel | 17.7 |

## IV

# TANUPOLAMA, A NEW GENUS OF LLAMA FROM THE PLEISTOCENE OF CALIFORNIA

BY CHESTER STOCK

WITH SIX PLATES

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# TANUPOLAMA, A NEW GENUS OF LLAMA FROM THE PLEISTOCENE OF CALIFORNIA

By Chester Stock

## INTRODUCTION

The presence of a slender-limbed camel in the mammalian fauna of the McKittrick Pleistocene has been noted by Merriam and Stock.[1] In a later paper [2] this form was recognized as certainly distinct from the genus *Camelops* and described as *Lama stevensi*. Further study of materials collected at McKittrick for the California Institute of Technology by Charles H. Sternberg has convinced the writer that while the form is undoubtedly closely related to the living llamas of South America, certain noteworthy characters serve to distinguish the Pleistocene type from the genus *Lama*. In view of studies now in progress on the relationships of Pleistocene mammalian faunas of California it seems desirable to publish a statement of the generic characters of the McKittrick llama, reserving a fuller description of the California Pleistocene Camelidæ for a forthcoming paper.

The illustrations shown on plates 1 to 6 have been prepared by Mr. John L. Ridgway.

### Tanupolama, new genus

τανυπος, long-legged; lama, llama.

*Type specimen*—A fragmentary mandible with lower dentition, No. 24260 Mus. Pale., Univ. Calif., designated as the type of the species, *Lama stevensi* Merriam and Stock. McKittrick Pleistocene, California.

*Co-types*—Skulls, Nos. 3, 4, 5 and 6; mandible, No. 7; skeletal elements, Nos. 8, 9, 10, 11 and 12, Calif. Inst. Tech. Vert. Pale. Coll. All specimens from the McKittrick Pleistocene, California.

*Generic characters*—Size of average specimens larger than living llama, but smaller than *Camelops*.

Orbits smaller, brain-case larger and somewhat flatter dorsally than in *Lama*.

Posterior portion of mastoid region and paroccipital process situated closer to basioccipital and occipital condyles than in living genus. Deep narrow groove on postero-external side of mastoid behind stylo-hyal pit. Paroccipital process bluntly pointed and not projecting inward in its downward course.

Lower canine present or absent. Lower molars with inner enamel surfaces flatter and median longitudinal groove of inner side not as deep as in

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[1] J. C. Merriam and C. Stock, Science, n.s., vol. 54, pp. 566–567, 1921.

[2] J. C. Merriam and C. Stock, Carnegie Inst. Wash. Publ. No. 347, Art. II, pp. 39–42, 1925.

*Lama.* Antero-external style not as well developed as in living genus. Posterior lobe of M$\overline{3}$ wider transversely and less prominently constricted from second lobe.

Atlas longer than in *Lama* and posterior opening of vertebrarterial canal situated on dorsal surface in front of posterior border. Limb elements much more slender than those of *Camelops.* Radius-ulna and cannon bones greatly elongated. Metapodials in some individuals approaching those of *Camelops hesternus* in length.

## SKULL

The skull of *Tanupolama* approximates that of *Lama* more closely in size and in general outline than does that of *Camelops.* Several incomplete skulls and mandibles are available from the McKittrick deposits. No. 3 C. I. T. Vert. Pale. Coll. (Plates 1 and 2) in which Dm$\underline{2}$, Dm$\underline{3}$ and Dm$\underline{4}$ are still in function, belongs to a relatively young individual. Nos. 4 and 5 (Plate 3) represent skulls of adult forms.

The nasals are nearly completely preserved in skull No. 4. In this specimen (Plate 3, fig. 1) these elements are seen to be relatively narrow. The base of the nasal forming the upper border of the lachrymal vacuity is also narrow in an anteroposterior direction. The fronto-nasal suture is similar to that in *Lama.* The frontals are broad with small frontal foramina from which shallow grooves extend forward. In skull No. 3 these foramina lie distinctly farther forward with reference to the posterior border of the orbit than in *Lama.* Their position in skull No. 4 is, however, more like that in the Recent genus. The brain-case is not completely preserved in any of the specimens from McKittrick. In specimen No. 3 the brain-case is seen to be quite capacious and its dorsal surface is somewhat flattened.

A small depression or fossa is present in the facial portion of the maxillary below the nasal border and above and slightly in advance of the infraorbital foramen. The upper posterior border of the depression is sharply defined. A similar fossa occurs in *Camelops,* but is apparently absent in the living llama. The outlines of the lachrymal vacuity are not clearly shown, but the latter appears to have been comparable in size to that of *Lama.* The vacuity is distinctly smaller than in *Camelops.*

The orbit has approximately the position seen in *Lama,* but is smaller than in the latter form. The single lachrymal foramen is large. The jugal is a slender element. In skull No. 3 the maxillary lying below the jugal develops a ridge posteriorly. The premaxillaries have essentially the shape seen in *Lama.* The maxillary portion of the palatal region of the snout is broad. In skull No. 4 the posterior palatine foramina have a position opposite the front end of P$\underline{3}$. This appears to be the case also in skull No. 5 (Plate 3, fig. 2). In skull No. 3 (Plate 2, fig. 1) the foramina are located opposite the anterior milk teeth of the cheek-tooth dentition. The palatine border of the posterior nares forms a V-shaped notch. In skull No. 3 this notch is narrower than in skull No. 4. The notch in *Lama* is subject to considerable variation in shape as noted by Peterson.[3] A deep indentation of the posterior palatal border occurs on each side of the postnarial notch in skull No. 3. Their depth is also a variable character.

The posterior portion of the vomer and the elements of the basicranial region of the skull have much the same development in *Tanupolama* as in *Lama.* The base of one pterygoid is preserved in skull No. 3. The mastoid region is not entirely preserved. The paroccipital process comes to a blunt point. The deep pit between this process and the condyle does not appear to be as wide as in the Recent llama. The foramen lacerum posterius is smaller than in skulls of *Lama*. On the posteroexternal side of the mastoid a deep groove extends upward from the rim of the stylo-hyal pit, but this groove is not as broad as in the llama. In skull No. 3 the ventral surfaces of the occipital condyles are more widely separated than in *Lama*. Illustrations of skulls of the living llama shown by Peterson[4] indicate that this character is variable in the latter form. A large squamosal canal is present behind and to the outer side of the postglenoid fossa.

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[3] O. A. Peterson, Ann. Carnegie Mus., vol. 2, pp. 444–445, 1904.

In posterior view of skull (Plate 2, fig. 1*b*) the paroccipital process is seen to extend downward but does not curve inward as in *Lama*. Unfortunately the occiput is not well preserved and the details of structure in the region between the foramen magnum and the superior crest can not be determined. A median occipital crest may have been present as in *Lama*.

The mandible of *Tanupolama* (Plate 4, figs. 2 and 3) is comparable to that of *Lama* in general shape and in slenderness. It is considerably less robust than that of *Camelops hesternus*. As indicated in the original description of *Tanupolama stevensi* the inferior border of the horizontal ramus in the McKittrick form is practically straight from a point below M$\bar{3}$ to the symphysis, thus differing from *Lama*. The anterior mental foramen is large. A small posterior mental foramen is situated below P$\bar{4}$. The symphyseal region may be relatively longer and more slender than in the living llama. The coronoid process is slender and curves backward at the tip as in *Lama*.

*Measurements (in millimeters) of skulls and mandibles*

| | |
|---|---|
| Specimen No. 3— | |
| Greatest width across frontals measured between orbital rims (approximate) | 165.0 |
| Greatest width across occipital condyles | 51.3 |
| Width measured from middle of anterior rims of orbits | 125.5 |
| Width of palate measured between middle of posterior lobes of first molars | 48.8 |
| Length of mandible from anterior end of symphysis to posterior end of angle; measurement taken parallel to long diameter of horizontal ramus | 245.7 |
| Length of symphysis | 61.7 |
| Greatest width of symphyseal region | 30.6 |
| Length of diastema between root of deciduous canine and Dm$\bar{3}$ | 58.8 |
| Specimen No. 4— | |
| Width of snout between upper borders of maxillary fossæ | 47.4 |
| Width of palate measured between middle of anterior lobes of second molars | 48.2 |
| Specimen No. 5— | |
| Length from anterior end of premaxillary to middle of line connecting posterior ends of third molars | 220.0 |
| Length from anterior end of premaxillary to anterior side of upper incisor | 40.6 |
| Least width of palatal portion of maxillaries anterior to cheek-teeth | 20.6 |
| Width of palate between anterior lobes of second molars | 48.4 |
| Length of mandible from anterior end of symphysis to posterior end of angle; measurement taken parallel to lower border of horizontal ramus | 283.0 |
| Height of condyle above lower border of ramus | 120.0 |
| Length of symphysis | 74.3 |
| Length of diastema between caniniform P$\bar{1}$ and P$\bar{4}$ | 60.3 |
| Least width across symphysis and behind caniniform premolar | 28.8 |
| Height below anterior end of P$\bar{4}$ taken normal to lower border | 31.2 |
| Height below posterior end of M$\bar{3}$ taken normal to lower border | 53.7 |
| Specimen No. 6— | |
| Length from anterior end of premaxillary to anterior end of third incisor | 43.8 |
| Width of maxillaries between outer alveolar borders of canines | 29.0 |
| Least width of palatal portion of maxillaries anterior to cheek-teeth | 16.5 |

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[4] O. A. Peterson, *op. cit.*, figs. 1 and 2, p. 444, 1904.

Specimen No. 7—

| | |
|---|---|
| Length from anterior end of symphysis to posterior end of angle (approximate); measurement taken parallel to lower border of horizontal ramus | 284.0 |
| Height from lower border of ramus to tip of coronoid process (approximate) | 166.5 |
| Height of angle above lower border of ramus | 115.5 |
| Length of symphysis (approximate) | 70.4 |
| Length of diastema between caniniform premolar and P$\overline{4}$ | 54.8 |
| Height below anterior end of P$\overline{4}$ taken normal to lower border | 30.9 |
| Height below posterior end of M$\overline{3}$ taken normal to lower border | 51.9 |

## DENTITION

$$\text{Dental Formula: } \frac{1\text{–}0}{3}, \ \frac{1\text{–}0}{1\text{–}0}, \ \frac{2}{3\text{–}2}, \ \frac{3}{3}.$$

The total number of teeth in the permanent dentition of *Tanupolama* may be 34 or this number may be reduced to that seen in the living llama. The total number of teeth may be still further reduced by the loss in the upper dentition of the single incisor and the canine. The lower canine is frequently absent. P$\overline{3}$ may occasionally be present as in No. 24258 Univ. Calif. Coll.

On Plate 2, figure 2, a premaxillary-maxillary fragment of a skull, No. 6 C. I. T. Coll. Vert. Pale., is shown in which the superior incisor and canine are very small teeth. In skull No. 3 (Plate 2, fig. 1), the upper canine is absent. This specimen, however, belongs to a young individual in which deciduous teeth are present in the cheek-tooth region. Unfortunately the premaxillary portion of the skull in specimen No. 3 has not been preserved.

In the cheek-tooth dentition P$\underline{3}$ to M$\underline{3}$ form a continuous series. In P$\underline{3}$ the inner lobe of the tooth, as in *Lama*, is not completely formed. A rudimentary fold of the enamel extends inward from each end of the outer crest, but these folds do not meet. In P$\underline{4}$ the external enamel surface is folded not quite so strongly as in the living llama. The superior molars likewise exhibit less pronounced folding of the external enamel surface and the parastyle and mesostyle appear to be less prominent in these teeth than in the comparable teeth of the living species.

The lower incisors may be slightly more procumbent than in *Lama*. In *Tanupolama* I$\overline{3}$ may have a somewhat broader crown than in *Lama*. In some specimens from McKittrick, as for example, mandibles Nos. 5 and 7, a canine tooth is present immediately behind the third incisor. The crown of this tooth is narrow transversely and projects forward. Behind this tooth and separated from it by a short diastema is a caniniform tooth with recurved crown which is larger than the true canine. This tooth evidently represents a caniniform premolar, presumably P$\overline{1}$. When the canine is absent as in mandible No. 24260 Univ. Calif. Coll. the caniniform premolar is separated by a diastema from I$\overline{3}$. This tooth is apparently identical with the so-called lower canine tooth in *Lama*. In other words, it would appear that in the modern llama the true canine has disappeared and that P$\overline{1}$ in this type has been generally regarded as the canine. It has been wrongly designated a canine tooth in the original description of the species *Tanupolama stevensi*. Thus it follows that the dentition of *Lama* differs from that of *Camelus* in the reduction of the lower canine and not in the disappearance of the lower anterior premolar.[5]

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[5] In a recent discussion of the dentition of the South American *Lama*, Anat. Anz., Bd. 62, pp. 97–109, 1926, Rud. Süppel differs in his interpretation of the dental formula from that reached by previous authors. Süppel gives the formula as $\frac{\text{I3}}{\text{I1I2I3}}, \frac{\text{C}}{\text{(C)}}, \frac{\text{P3P4}}{\text{P3P4}}, \frac{\text{M1M2M3}}{\text{M1M2M3}}$.

In the mandible of specimen No. 3 in which Dm$\overline{3}$ and Dm$\overline{4}$ are present in the cheek-tooth region, the crowns of the third deciduous incisor and canine are also preserved. The milk canine differs in size and somewhat in shape from the permanent tooth. A long diastema separates the milk canine from the deciduous molars.

*Measurements (in millimeters) of superior dentition*

| | No. 3 | No. 4 | No. 5 | No. 6 |
|---|---|---|---|---|
| I$\underline{3}$, anteroposterior diameter | | | 6.2 | 2.5 |
| C, anteroposterior diameter | | | 6.4 | 4.2 |
| P$\underline{3}$, greatest anteroposterior diameter (taken at base of crown) | | 12.7 | 13.7 | |
| P$\underline{3}$, greatest transverse diameter (taken at base of crown) | | 8.5 | 7.5 | |
| P$\underline{4}$, greatest anteroposterior diameter | | 15.8 | 15.6 | |
| P$\underline{4}$, greatest transverse diameter | | 13.2 | 14.7 | |
| M$\underline{1}$, greatest anteroposterior diameter | | 23.0 | 19.4 | |
| M$\underline{1}$, greatest transverse diameter | | 21.0 | 25.8 | |
| M$\underline{2}$, greatest anteroposterior diameter | 29.7 | 28.7 | 23.9 | |
| M$\underline{2}$, greatest transverse diameter | 17.0 | 19.0 | 25.3 | |
| M$\underline{3}$, greatest anteroposterior diameter | 31.4 | 27.7 | 31.3 | |
| M$\underline{3}$, greatest transverse diameter | 15.5 | 15.8 | 23.9 | |
| Length from anterior side of P$\underline{3}$ to posterior side of M$\underline{3}$ | | 99.3 | 96.4 | |
| Length from anterior side of Dm$\underline{2}$ to posterior side of M$\underline{2}$ | 97.4 | | | |
| Dm$\underline{2}$, greatest anteroposterior diameter | 6.9 | | | |
| Dm$\underline{3}$, greatest anteroposterior diameter | 19.9 | | | |
| Dm$\underline{3}$, greatest transverse diameter | 14.6 | | | |
| Dm$\underline{4}$, greatest anteroposterior diameter | 23.9 | | | |
| Dm$\underline{4}$, greatest transverse diameter | 16.4 | | | |

*Measurements (in millimeters) of inferior dentition*

| | No. 3 | No. 4 | No. 5 | No. 7 |
|---|---|---|---|---|
| I$\overline{1}$, transverse diameter | | | | 13.0 |
| I$\overline{2}$, transverse diameter | | | 7.0 | 11.9 |
| I$\overline{3}$, transverse diameter | | | 6.8 | 10.0 |
| C, anteroposterior diameter | | | 6.4 | 7.2 |
| P$\overline{1}$, anteroposterior diameter | | | 8.6 | 11.4 |
| P$\overline{4}$, greatest anteroposterior diameter | | 15.2 | 14.0 | 17.8 |
| P$\overline{4}$, greatest transverse diameter | | 8.7 | 7.7 | 8.8 |
| M$\overline{1}$, greatest anteroposterior diameter | | 21.2 | | 21.0 |
| M$\overline{1}$, greatest transverse diameter | | 14.4 | | 14.9 |
| M$\overline{2}$, greatest anteroposterior diameter | | 25.3 | 24.0 | 29.4 |
| M$\overline{2}$, greatest transverse diameter | | 14.1 | 16.6 | 16.8 |
| M$\overline{3}$, greatest anteroposterior diameter | | 31.7 | 37.6 | 36.1 |
| M$\overline{3}$, greatest transverse diameter | | 12.4 | 16.3 | 14.8 |
| Length from anterior side of P$\overline{4}$ to posterior side of M$\overline{3}$ | | 91.9 | 94.2 | 102.0 |
| Length from anterior side of P$\overline{1}$ to posterior side of M$\overline{3}$ | | | 168.8 | 168.8 |
| Length from anterior side of I$\overline{3}$ to posterior side of M$\overline{3}$ | | | 205.3 | 210.2 |
| DI$\overline{3}$, transverse diameter | 6.9 | | | |
| DC, anteroposterior diameter | 5.3 | | | |
| Dm$\overline{4}$, greatest anteroposterior diameter | 27.3 | | | |
| Dm$\overline{4}$, greatest transverse diameter | 10.8 | | | |

$P\bar{1}$ frequently has a scimitar-like crown which is quite thin transversely. As in *Lama* a long diastema separates this tooth from the posterior premolars. $P\bar{3}$ is only occasionally present in the fossil species. In No. 24260, as stated in the original description of the McKittrick type, the crown of $P\bar{3}$ consists of a single cusp compressed transversely and supported on a single root. $P\bar{4}$ closely resembles that of *Lama* in stage of development, but the anterior portion of the internal surface is apparently not so deeply infolded as in the latter genus. In the lower molars of the McKittrick genus the inner enamel surface is not so strongly folded as in the modern type. The antero-external style, while present in lower molars of *Tanupolama,* is not as well developed as in *Lama.* This style is absent in the posterior molars of *Camelops hesternus.* The inner surface of the posterior lobe in $M\bar{3}$ is not so distinctly set off from that of the second lobe as in the Recent *Lama.*

## SKELETAL ELEMENTS

*Atlas*—The first cervical vertebra (Plate 2, fig. 3) is relatively narrow and distinctly longer than the atlas of the living llama. The ventral keel is not sharply defined, but the ventral tubercle is broad. The posterior opening of the vertebrarterial canal is situated somewhat in advance of the lateral border of the articulating surface for the axis. In other words, the entrance of the vertebral artery lies farther forward than in *Lama.* On the ventral surface of the wing of the atlas the vertebrarterial canal enters a much smaller depression than that in *Lama.* The posterior lateral margin of the wing or transverse process is situated close to the articulating surface for the axis.

Measurements in millimeters of atlas (No. 8 C. I. T. Coll.) are: greatest length, 80.1; width of anterior end, 59.3; width of posterior end, 72.6; greatest depth of posterior end, 45.3; greatest transverse diameter of neural canal at posterior end, 28.5.

*Humerus*—In this limb element (Plate 5, figs. 1, 1*a*), the bicipital grooves are quite shallow, much more so than in the living llama. The convexity lying between these grooves is broad. The greater tuberosity does not project dorsally and its outer face is distinctly flattened. The deltoid tuberosity lies well up on the shaft. The olecranon fossa in specimen No. 9 is narrower than in the humerus of *Lama.*

Measurements in millimeters of humerus (No. 9 C. I. T. Coll.) are: greatest length, 325.0; greatest width of proximal end (approximate), 84.5; antero-posterior diameter through middle of proximal end, 93.7; width of shaft at middle, 36.0; width of distal articulating end, 63.7.

*Radius-Ulna*—The degree of fusion of the two fore-arm bones in *Tanupolama* is comparable to that in *Lama.* The combined elements in the Pleistocene form (Plate 5, figs. 2, 2*a*) have a length which is distinctly greater than that of the radius-ulna in the living genus. The radius is also much less bowed in its longitudinal extent than in the existing form. The olecranon process is decidedly shorter. In the specimen figured this process appears to be slightly wider transversely than in *Lama.*

Measurements in millimeters of radius-ulna (No. 10 C. I. T. Coll.) are: greatest length, 501.7; width of proximal end of radius, 66.7; length from semi-lunar notch to end of olecranon process, 61.8; width at middle of shaft (approximate), 40.6; greatest width of distal extremity, 63.6.

*Metapodials*—The anterior and posterior metapodials (Plate 6) show a pronounced slenderness and elongation. These elements reach a length decidedly greater than that seen in the modern llama. In this character the metapodials of *Tanupolama* are more like those in the large *Camelops hesternus*, although differing noticeably from the latter in their slenderness. The median cleft of the distal end separating the third and fourth elements does not extend relatively as far in a proximal direction in the Pleistocene type as in the Recent genus.

Measurements in millimeters of anterior cannon bone (No. 11 C. I. T. Coll.) are: greatest length, 409.7; width of proximal end, 50.9; anteroposterior diameter of proximal end, 38.0; width of shaft at middle, 28.0; anteroposterior diameter of shaft at middle, 29.4; width of distal end, 60.4.

Measurements in millimeters of posterior cannon bone (No. 12 C. I. T. Coll.) are: greatest length, 417.2; width of proximal end, 52.2; anteroposterior diameter of proximal end, 42.2; width of shaft at middle, 28.8; anteroposterior diameter of shaft at middle, 32.2; width of distal end, 61.3.

## RELATIONSHIP OF TANUPOLAMA TO CAMELUS AMERICANUS WORTMAN

The species *Camelus americanus*, described by Wortman[6] on the basis of an incomplete mandible from the Hay Springs Pleistocene of Nebraska, was regarded as a camelid type distinct from the American llama and related to the Old World genus *Camelus*. The relationship was based on the lower dentition. In this specimen a rather weak incisiform canine is present behind I$\overline{3}$. Posterior to the canine and separated from it by a short diastema is a caniniform premolar apparently P$\overline{1}$.

As will be noted from the description of the McKittrick specimens this corresponds with the dentition in the California species. These teeth show a considerable resemblance in shape to the corresponding teeth in *Tanupolama stevensi*. Moreover, Wortman indicated the presence of an antero-external style, weakly developed in M$\overline{2}$ and quite distinct in M$\overline{3}$. The style is likewise present in *T. stevensi*. There also appears to be close similarity between the Nebraska and California forms in size.

In the specimens from McKittrick the anterior border of the symphysis does not extend so abruptly upward from the lower border of the ramus as in *Camelus americanus*.

The characters exhibited by Wortman's specimen would seem to indicate quite clearly a species falling within the generic group *Tanupolama*.

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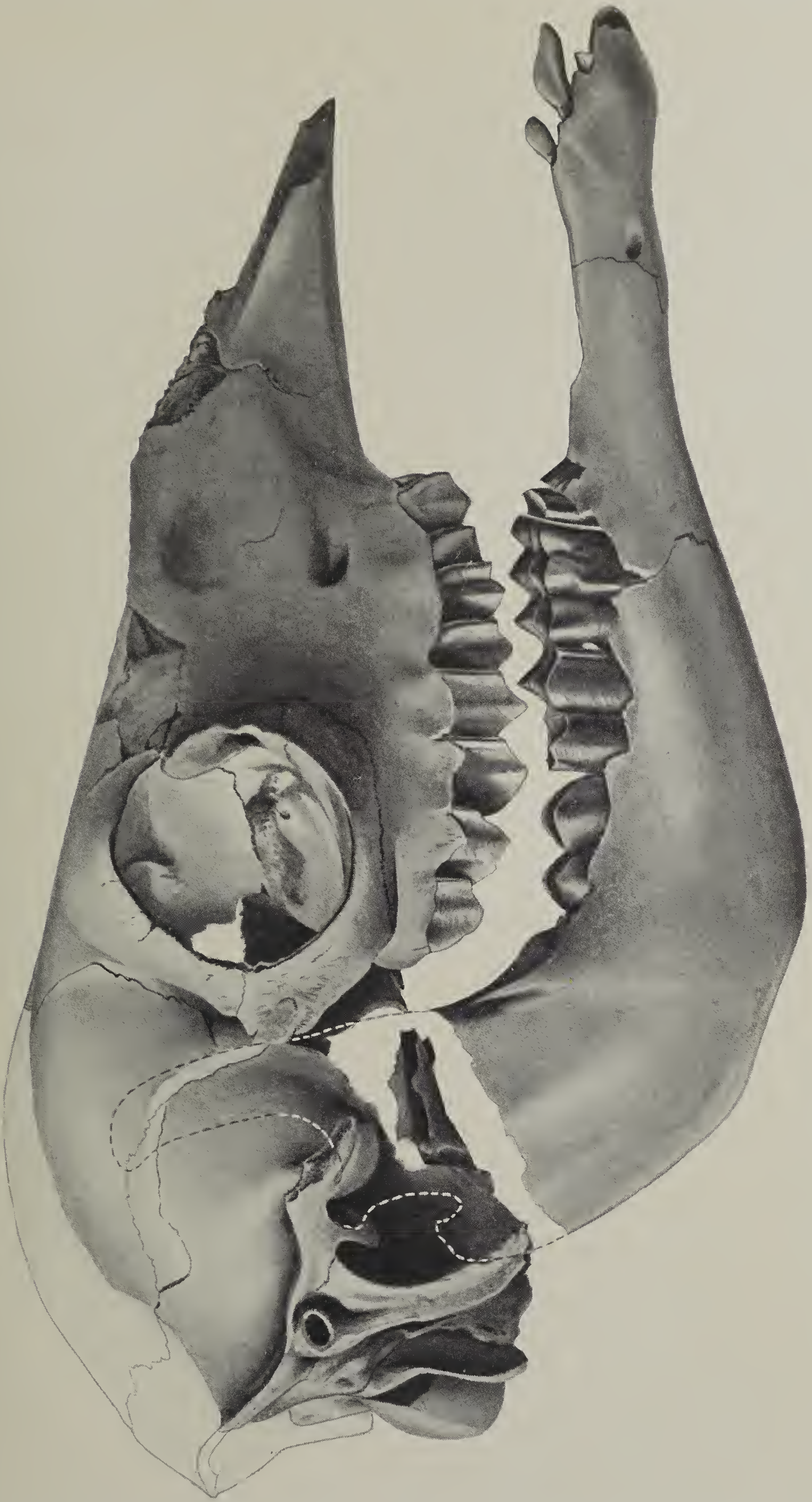
[6] J. L. Wortman, Bull. Amer. Mus. Nat. Hist., vol. 10, pp. 133–134, fig. 21, 1898.



*Tanupolama stevensi* (Merriam and Stock). Skull, No. 3 C. I. T. Coll., lateral view. ×0.66.
McKittrick Pleistocene, California.

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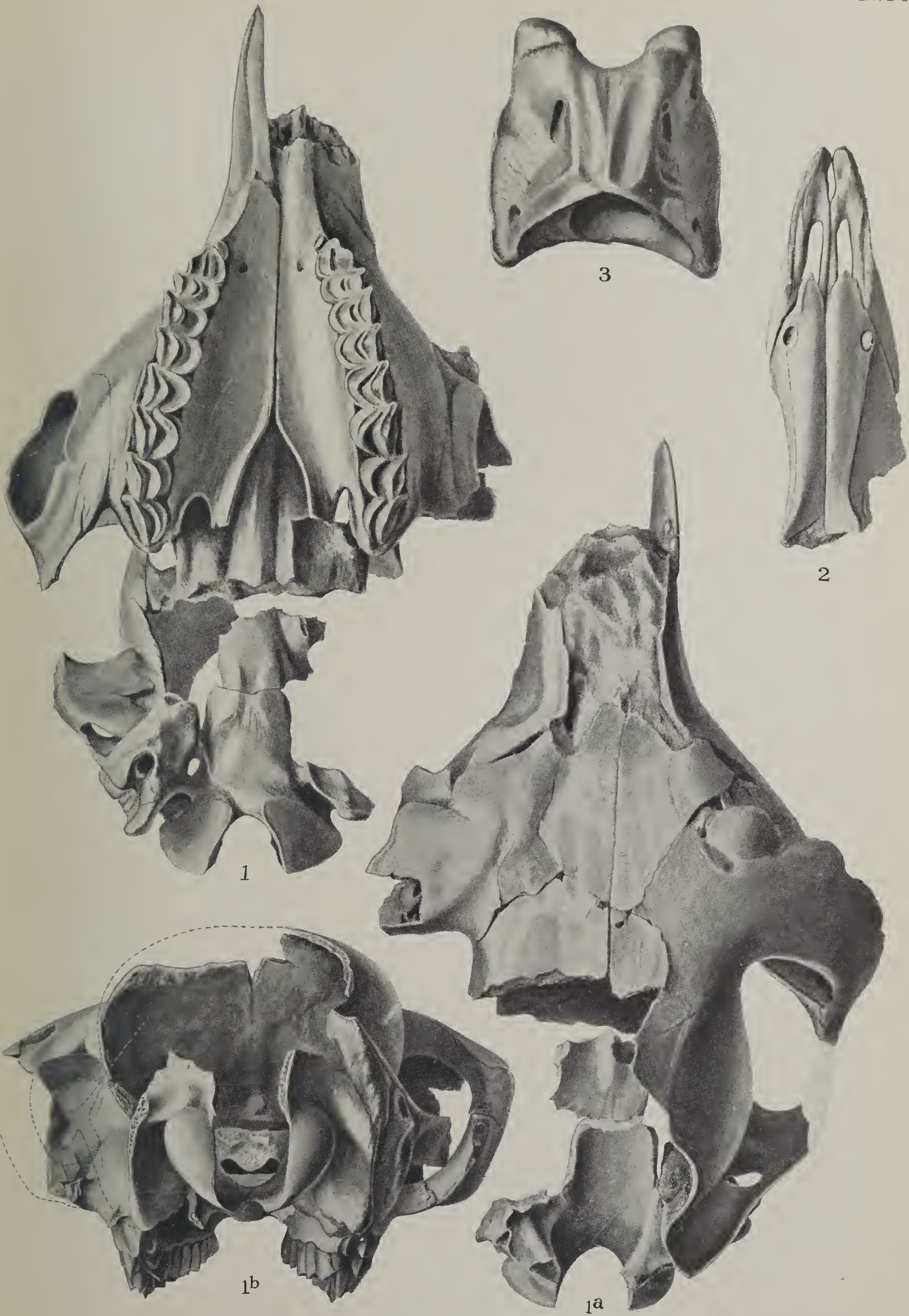
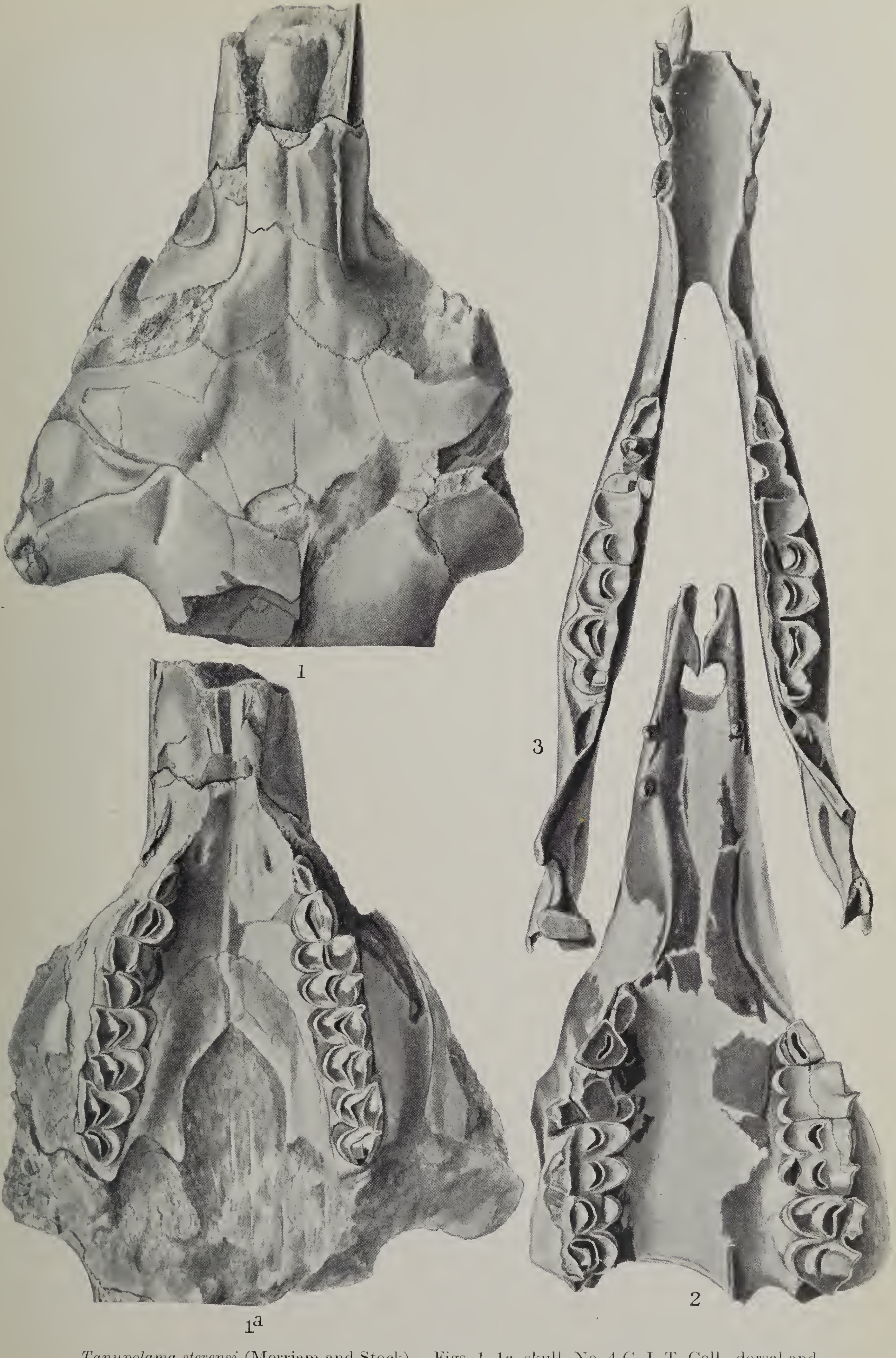


*Tanupolama stevensi* (Merriam and Stock). Figs. 1, 1*a* and 1*b*, skull, No. 3 C. I. T. Coll., ventral, dorsal and posterior views. Fig. 2, skull No. 6 C. I. T. Coll., ventral view of anterior portion of palate. Fig. 3, atlas, No. 8 C. I. T. Coll., dorsal view. ×0.50. McKittrick Pleistocene, California.



*Tanupolama stevensi* (Merriam and Stock). Figs. 1, 1*a*, skull, No. 4 C. I. T. Coll., dorsal and ventral views. Fig. 2, skull, No. 5 C. I. T. Coll., ventral view; fig. 3, mandible, No. 5, dorsal view. ×0.50. McKittrick Pleistocene, California.

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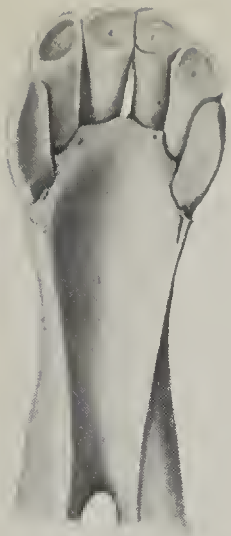

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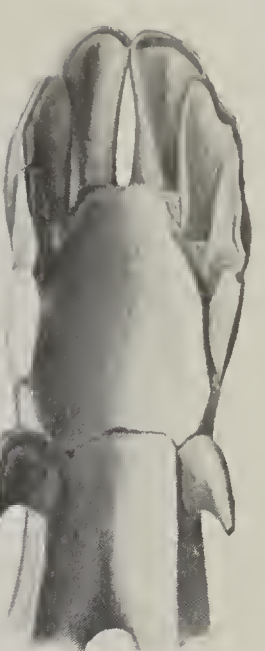

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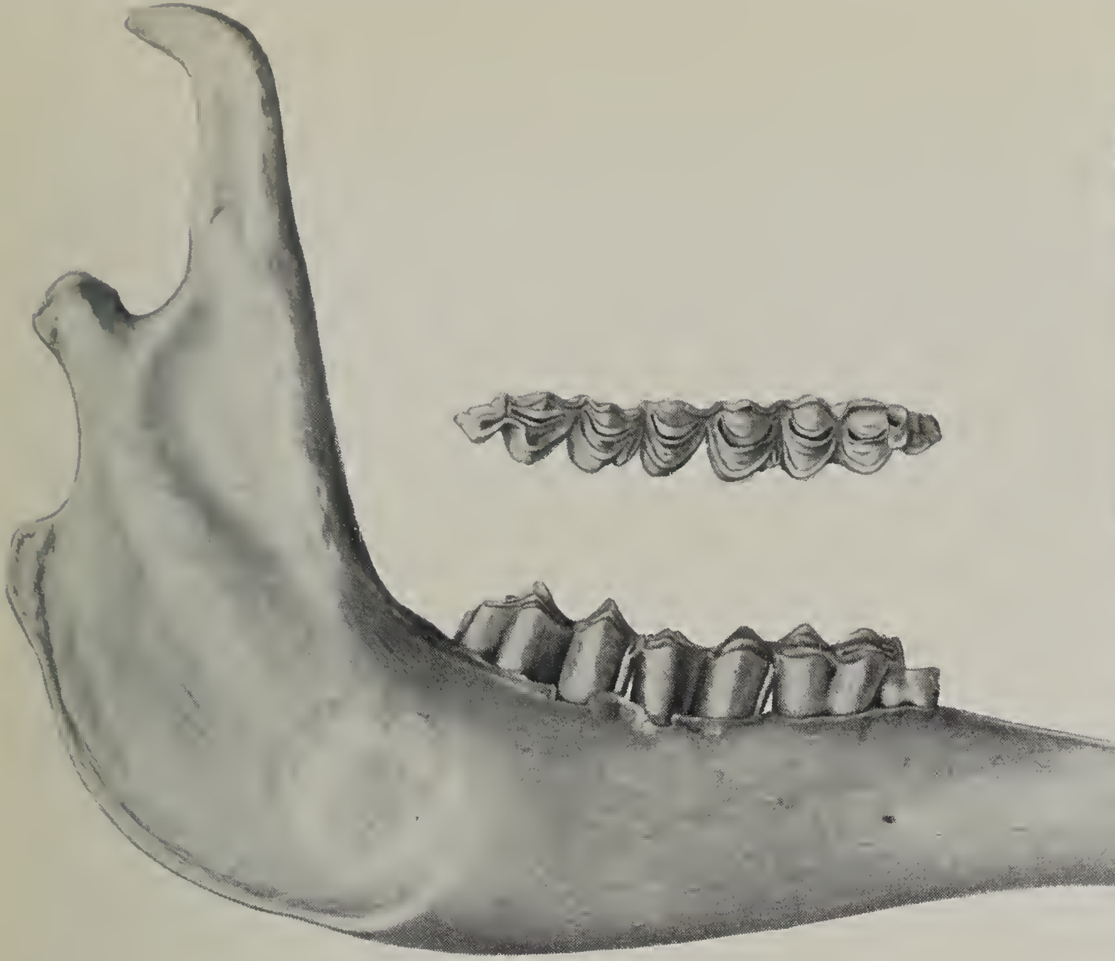

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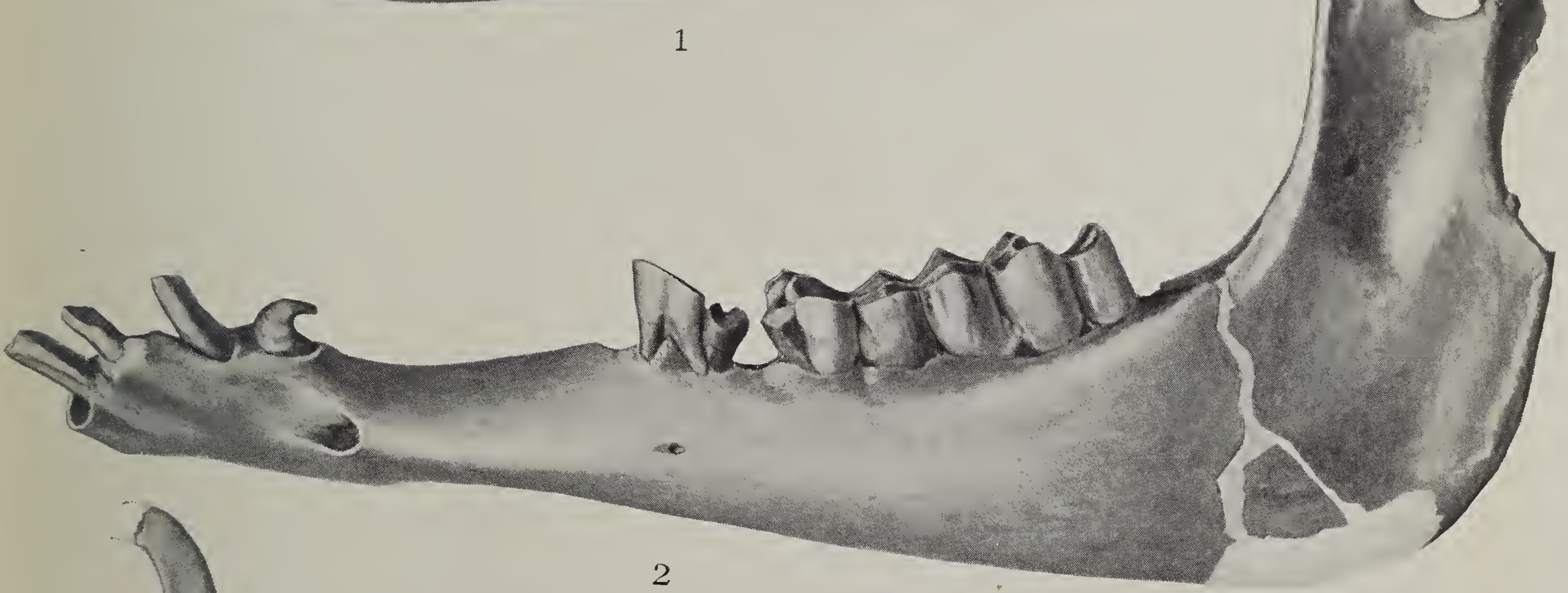

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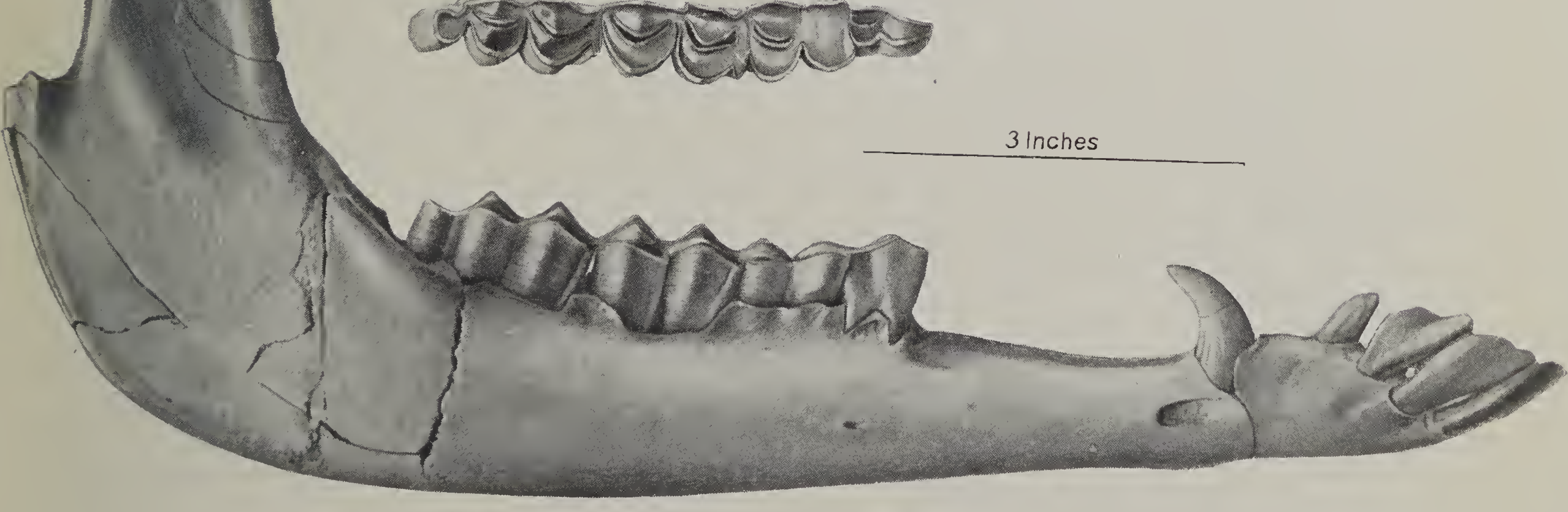

3

*Lama huanacos.* Fig. 1, mandible, No. 92136 U. S. Nat. Mus., lateral view and occlusal view of cheek-teeth. Fig. 4, mandible, No. 92138 U. S. Nat. Mus., dorsal view of symphyseal region. ×0.50. Recent, South America.

*Tanupolama stevensi* (Merriam and Stock). Fig. 2, mandible, No. 5 C. I. T. Coll., lateral view. ×0.50. Figs. 3, 3*a*, mandible, No. 7 C. I. T. Coll.; fig. 3, lateral view and occlusal view of cheek-teeth. Slightly less than one-half natural size; fig. 3*a*, dorsal view of symphyseal region. ×0.50. McKittrick Pleistocene, California.

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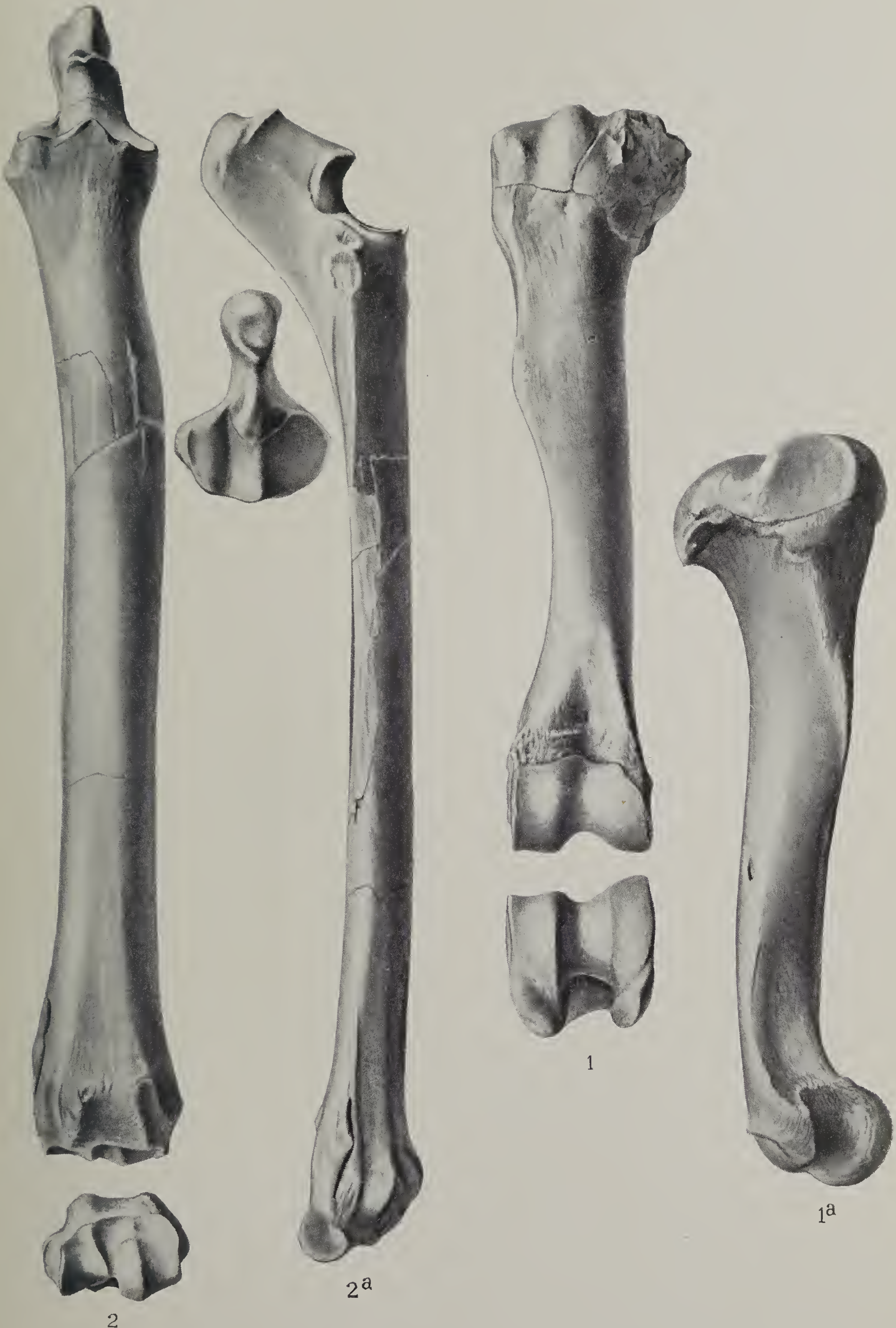
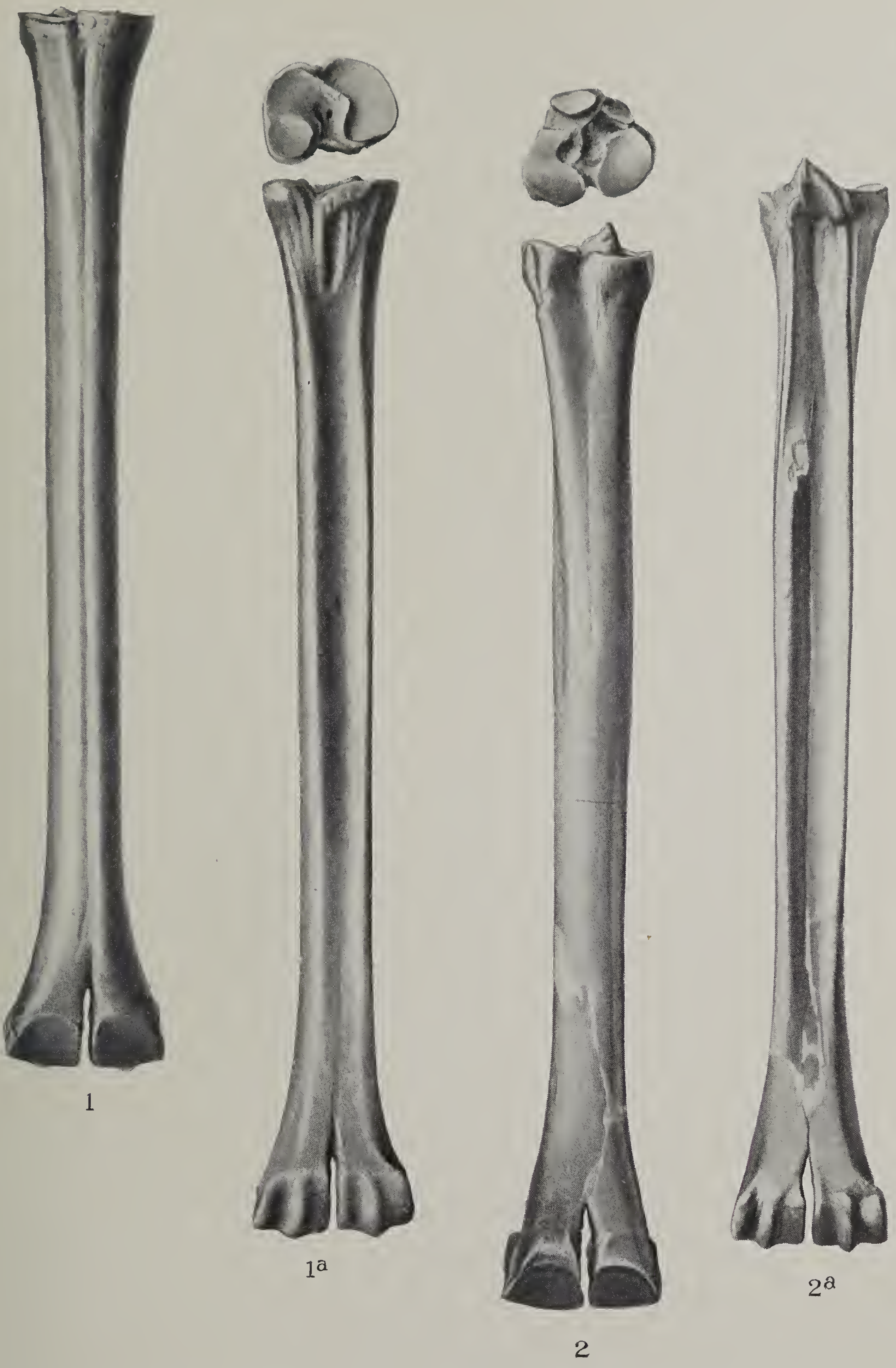


*Tanupolama stevensi* (Merriam and Stock). Figs. 1, 1*a*, humerus, No. 9 C. I. T. Coll., anterior and lateral views and view of distal end. Figs. 2, 2*a*, radius-ulna, No. 10 C. I. T. Coll., anterior, distal, proximal, and lateral views. ×0.333. McKittrick Pleistocene, California.



*Tanupolama stevensi* (Merriam and Stock). Figs. 1, 1*a*, anterior cannon bone, No. 11 C. I. T. Coll., anterior, posterior, and proximal views. Figs. 2, 2*a*, posterior cannon bone, No. 12 C. I. T. Coll., anterior, posterior, and proximal views. ×0.333. McKittrick Pleistocene, California.

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# V

# CANID AND PROBOSCIDEAN REMAINS FROM THE RICARDO DEPOSITS, MOHAVE DESERT, CALIFORNIA

BY CHESTER STOCK

WITH FOUR PLATES AND ONE TEXT-FIGURE

# CANID AND PROBOSCIDEAN REMAINS FROM THE RICARDO DEPOSITS, MOHAVE DESERT, CALIFORNIA

By Chester Stock

Among the canid remains obtained by University of California collecting parties in the upper portion of the Ricardo beds of the Mohave Desert were several specimens provisionally referred by Merriam[1] to the genus *Ælurodon.* A maxillary fragment with posterior cheek-teeth, No. 21507 U. C. Coll., furnished the type of the species *Ælurodon? aphobus* Merriam. A second specimen, a mandibular ramus, No. 22470 U. C. Coll., with well-worn teeth was regarded by Merriam as possibly belonging to *Æ.? aphobus,* this relationship being suggested by the size and proportion of the teeth in the latter form.

Since publication of Merriam's report on the Ricardo fauna there has appeared Matthew's third contribution to the Snake Creek fauna. In this report Matthew[2] refers to the *Ælurodon* specimens described from the Ricardo, regards *Ælurodon aphobus* as closely related to *Æ. haydeni validus* from the Snake Creek, and suggests further that the Ricardo type may be a subspecies of *Æ. haydeni.*

Later collecting in the Ricardo deposits has brought to light little additional material belonging to *Ælurodon.* A fragmentary mandibular ramus of this form, likewise from the upper Ricardo beds in the vicinity of Red Rock Cañon, was obtained by Mr. J. W. Lytle of the Los Angeles Museum. The specimen, No. 6 L. A. Mus. Coll. (Plate I, fig. A), fortunately preserves the canine, P$\overline{2}$ to M$\overline{2}$, in a moderate state of wear. The alveoli for P$\overline{1}$ and M$\overline{3}$ are also shown in this specimen. No. 6 furnishes therefore a satisfactory basis for comparing the Ricardo type with *Ælurodon* species of the Great Plains region, particularly with those forms known by mandibular fragments. A more detailed comparison is now also permitted between the lower jaw material from the Ricardo and the type of *Ælurodon aphobus* than is possible from the specimens available in the University collections.

In No. 6 the crown of the lower canine is relatively small and slender. The premolars are situated close together in fore and aft line. The alveolus for P$\overline{1}$ shows that this tooth was single-rooted. P$\overline{2}$ is two-rooted, with the roots fused. P$\overline{2}$ and P$\overline{3}$ have simple, single-cusped crowns. P$\overline{4}$ has the characteristic shape and position seen in *Ælurodon.* The posterior border truncates the tooth obliquely. In M$\overline{1}$ the metaconid is low and quite distinct from the protoconid. The hypoconid and entoconid are both well-developed cusps. In $M\overline{2}$ the two roots are widely divergent, a character noted by Leidy in *Ælurodon haydeni*. The worn occlusal surface shows clearly the arrangement of the cusps. A well-developed paraconid ridge extends inward from the large protoconid. The entoconid region is reduced, relatively more so than in *Canis*. The alveolus for $M\overline{3}$ indicates that the tooth possessed two roots which were fused.

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[1] J. C. Merriam, Univ. Calif. Publ. Bull. Dept. Geol., vol. 11, pp. 535–542, 1919.

[2] W. D. Matthew, Bull. Amer. Mus. Nat. Hist., vol. 50, p. 100, 1924.

Specimen No. 6 agrees closely in size and shape with the mandibular fragment, No. 22470 U. C. C., from the Ricardo, which has been regarded as possibly belonging to *Æ. aphobus*. A study of the lower dentition in No. 6 L. A. Mus. Coll. and of the teeth in the type of *Æ. aphobus* suggests quite strongly that the former specimen represents the same species to which the maxillary fragment has been assigned. In $M\overline{1}$ the paraconid-protoconid blade corresponds in length with the paracone-metacone blade of $P\underline{4}$ in No. 21507. When oriented in this position of shear, the hypoconid occludes with the protocone of $M\underline{1}$ and the entoconid apparently strikes the crown of this tooth between the protocone and the hypocone lobe. The paraconid and protoconid of $M\overline{2}$ occlude with the crown of $M\underline{1}$, in which respect *Ælurodon* differs from *Canis*.

As indicated by Matthew, *Æ. aphobus* is closely related to the Great Plains species *Æ. haydeni*. No. 6 agrees closely in size and shape with the type of *Æ. haydeni*. In the Ricardo specimen $M\overline{1}$ is slightly longer than that of Leidy's type, but $P\overline{3}$ is distinctly shorter. In $P\overline{4}$ of *Æ. haydeni* as shown by Leidy,[3] a slight but distinct cingulum extends along the outer side of the base of the crown above the posterior root. In the illustration of $P\overline{3}$ a similar development of the cingulum is suggested. A cingulum is only faintly indicated at the posterior end of the outer surface of $P\overline{4}$ and is entirely absent in $P\overline{3}$ of the specimen from Ricardo. Leidy states that in the Great Plains species the roots of $M\overline{3}$ are well separated. In No. 6 the roots of this tooth were evidently fused. The posterior root-socket of $M\overline{2}$ is elevated more along the side of the ascending portion of the ramus in Leidy's type than in the Ricardo form.

With the subspecies *Æ. haydeni validus* described by Matthew and Cook from the Snake Creek the Ricardo specimen again compares quite closely. The principal differences between the two forms seem to lie in a less transverse position of $P\overline{3}$ and in a greater depth of ramus below the anterior premolars in the Ricardo specimen. Matthew and Cook state that the canine alveolus in their specimen indicates a large and massive tooth. The lower canine is certainly not a large tooth in No. 6.

Records of the occurrence of *Ælurodon* in the Ricardo suggest the presence of this genus, particularly in the upper portion of the deposit.

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[3] J. Leidy, *The extinct mammalian fauna of Dakota and Nebraska, etc.*, Journ. Acad. Nat. Sci. Phila., ser. 2, vol. 7, pl. 1, fig. 10, 1869.

In this connection it is interesting to note that the amphicyonine dog *Hadrocyon* is known from a locality distinctly lower in the Ricardo. While the occurrences of these canid forms may be fortuitous, their distribution on the other hand may be indicative of a faunal difference between the upper and lower portions of the Ricardo section.

*Measurements (in millimeters) of No. 6 L. A. Mus. Coll.*

| | |
|---|---|
| Lower canine, anteroposterior diameter at base of enamel | 15.1 |
| Lower canine, transverse diameter at base of enamel | 12.8 |
| P$\overline{2}$, anteroposterior diameter | 9.8 |
| P$\overline{2}$, transverse diameter | 7.2 |
| P$\overline{3}$, anteroposterior diameter | 12.8 |
| P$\overline{3}$, transverse diameter | 8.3 |
| P$\overline{4}$, anteroposterior diameter | 20.1 |
| P$\overline{4}$, transverse diameter | 12. |
| M$\overline{1}$, anteroposterior diameter | 35.5 |
| M$\overline{1}$, transverse diameter across heel | 13.5 |
| M$\overline{2}$, anteroposterior diameter | 16. |
| M$\overline{2}$, transverse diameter | 10.6 |
| Length from anterior end of C to posterior alveolar border of M$\overline{3}$ | 130. |
| Length from anterior alveolar border of P$\overline{1}$ to posterior alveolar border of M$\overline{3}$ | 106.6 |
| Length from anterior end of P$\overline{3}$ to posterior alveolar border of M$\overline{3}$ | 90.4 |
| Depth of ramus measured between P$\overline{2}$ and P$\overline{3}$ (approximate) | 34.4 |

The fragmentary nature of the proboscidean remains heretofore secured from the Ricardo has permitted only a tentative determination of the mastodons occurring in the Ricardo fauna. Materials recently secured in these deposits by the Los Angeles Museum afford further opportunity to reach a determination of the generic type represented, and furnish moreover some information concerning a few skeletal elements of these forms.

The collection includes a fragmentary skull (Plate 1, figs. B and C), an incomplete mandibular ramus (text-fig. 1) and humerus, a femur and a calcaneum (Plates 2 and 3). The materials were found at three distinct localities in the Ricardo deposits.

### Trilophodon sp.

The skull, shown in Plate 1, was found near Iron Cañon in section 26, T. 29 S., R. 37 E., Mount Diablo B. and M. and prepared by J. W. Lytle. In this specimen (No. 1 L. A. Mus. Coll.) the palatal portion of the skull is preserved. The dentition includes the second and third molars. The two tusks are also present, although not completely preserved. No. 1 represents an individual approximating in size *Trilophodon productus*.

In ventral view the tusks are seen to diverge in their outward extent. They are likewise deflected downward as seen in side view. Remnants of enamel are to be seen on the tusks, the enamel extending along the surface for perhaps two-thirds the distance from tip to alveolar border. Near the tip of the right tusk the round-oval cross-section has been somewhat modified through attrition.

M$\underline{2}$ is greatly worn, but the crown of the tooth appears quite certainly to have possessed three transverse crests.

M$\underline{3}$ (Plate 1, fig. D) has three well-defined anterior crests which are followed posteriorly by two smaller crests. Not all of the tooth has undergone wear, for only the first crest is sufficiently worn to show a considerable area of dentine. The summit of the second ridge, particularly that portion of it formed by the inner cusp, is slightly worn. The first three transverse ridges are distinctly separated along the median line of the tooth into outer and inner cusps. In the first two crests these cusps are of nearly equal size. In the third the inner cusp is distinctly larger than the outer. A buttress is present at the antero-external side of the inner cusp of the first crest and extends forward to the middle of the anterior end of the tooth.

The valley between the first and second transverse crests and that between the second and third are open toward the outer side, but on the lingual side of the median line they are intercepted by buttresses formed on the anterior and posterior faces of the inner cusp of the second crest. The two crests lying posterior to the third transverse ridge are each made up of three tubercles.

A well-defined crenulated basal ridge or cingulum extends along the inner side of the tooth from a point in front of the inner cusp of the first crest to a point behind the third crest. The cingulum is apparent on the outer side between the transverse ridges and is well developed behind the outer cusp of the first crest where a small tubercle is formed.

In possessing a relatively simple type of crest development M$\underline{3}$ in No. 1 L. A. Mus. Coll. exhibits a character noted by Merriam for the last lower tooth in a mandibular fragment, No. 22681 U. C. Coll. from the Ricardo. The tooth in the latter form is approximately 150 mm. long, thus being slightly shorter than M$\underline{3}$ of the Los Angeles Museum specimen. The teeth have a similar number of cross-crests.

M$\underline{3}$ in the specimen from the Ricardo shows some resemblance to the comparable tooth of trilophodont mastodons recently described by Frick[4] from the Santa Fé beds of New Mexico. A last upper molar tentatively referred by Frick[5] to *Trilophodon productus* is smaller than the Ricardo tooth, but agrees with the latter in the comparative simplicity of the crown. In this tooth the tubercles of the last crest are not so well developed as in the Los Angeles Museum form.

*Trilophodon pojoaquensis* Frick is a larger type, in which M$\underline{3}$ possesses a greater number of accessory tubercles than in the Ricardo species. Furthermore, the Ricardo mastodon differs in having straighter tusks as seen in side view, and the palate in front of the second molars is not extended as much as in the species from the Santa Fé beds.

The characters seen in the Ricardo species indicate apparently a form not far removed in stage of development from the trilophodont mastodons of the late Miocene.

*Measurements (in millimeters) of skull, No. 1, L. A. Mus. Coll.*

| | |
|---|---|
| Length measured along median line from anterior end of palate to a point opposite posterior margin of M$\underline{3}$ (approximate) | 425. |
| Distance between inner borders of superior tusks immediately in front of alveolar borders | 96. |
| Greatest transverse diameter of left tusk immediately in front of alveolar border | 81.6 |
| Greatest transverse diameter of left tusk, taken 200 mm. in advance of point where preceding measurement was taken | 72.8 |
| Least distance between inner anterior borders of second superior molars (approximate) | 74.4 |
| Length measured from anterior end of M$\underline{2}$ to posterior end of M$\underline{3}$ (approximate) | 265. |
| M$\underline{2}$, greatest anteroposterior diameter (approximate) | 100.7 |
| M$\underline{2}$, greatest transverse diameter through middle of tooth | 67. |
| M$\underline{3}$, greatest anteroposterior diameter | 172.7 |
| M$\underline{3}$, transverse diameter across first crest (approximate) | 71. |
| M$\underline{3}$, transverse diameter across third crest | 69.5 |
| M$\underline{3}$, height of outer cusp of third crest measured from bottom of second valley to summit | 50.7 |

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[4] C. Frick, Bull. Amer. Mus. Nat. Hist., vol. 56, pp. 122–178, 1926.

[5] C. Frick, *op. cit.*, p. 144, fig. 22*c*, 1926.

### Trilophodon? sp.

An incomplete lower jaw, humerus and femur of a mastodon, possibly the genus *Trilophodon*, were collected at Los Angeles Museum Locality 1001 in the Ricardo deposits of Last Chance Cañon. The specimens, found by Howard R. Hill, came from a stratigraphic horizon not far below that containing the petrified trees located in section 8, T. 29 S., R. 30 E., Mount Diablo B. and M.

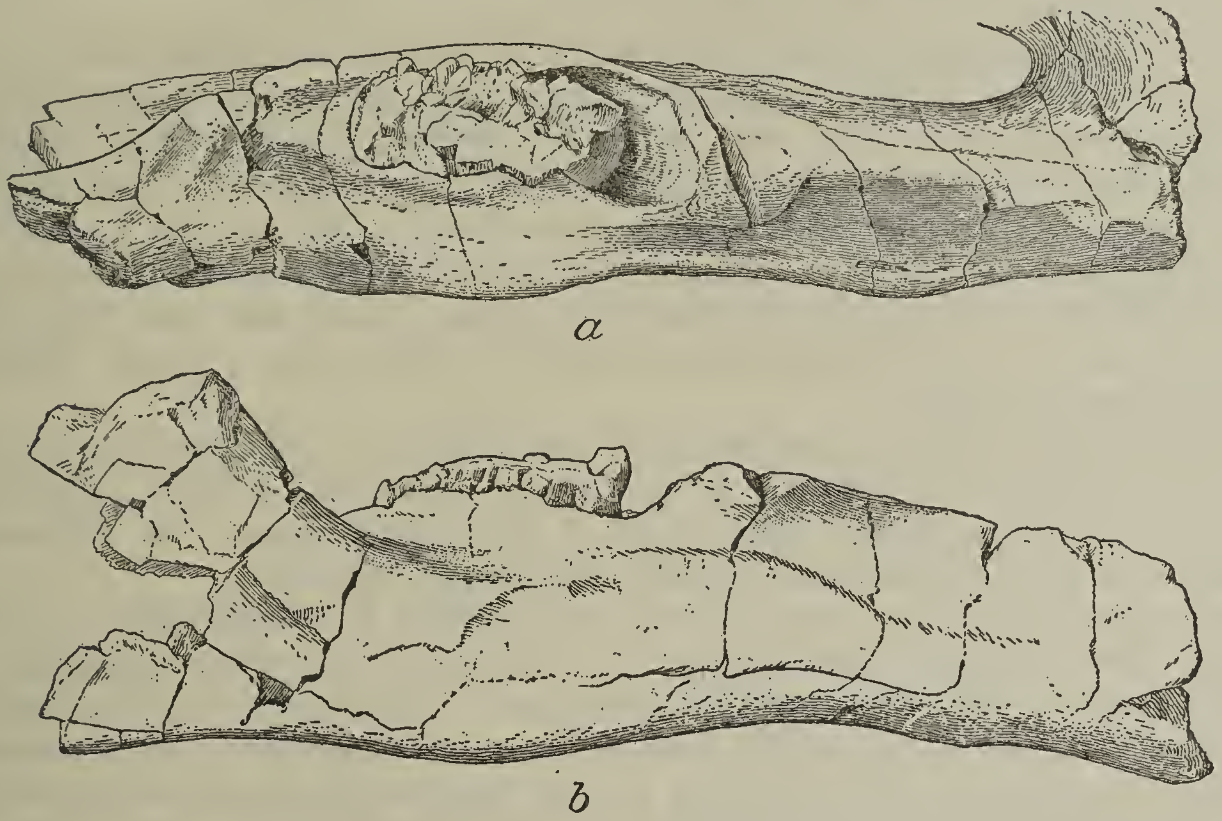

Fig. 1. *Trilophodon?* sp. Ramus of mandible, No. 4, L. A. Mus. Coll.; *a*, superior view; *b*, lateral view; ×0.166. Ricardo deposits, Mohave Desert, California.

The right ramus of the mandible, No. 4 L. A. Mus. Coll., is shown in text-figure 1. Unfortunately, the single tooth, apparently $M\overline{3}$, remaining in the jaw is badly damaged. The front end of the jaw is also broken away. No. 4 appears to resemble in size No. 22681 U. C. Coll., a portion of a mandible described by Merriam from the Ricardo. No. 4 differs from the latter in the outline of the lower border of the ramus. The horizontal ramus in front of the lower dentition is deflected downward and the posterior end of the symphysis is well in advance of the tooth row. The position of the posterior border of the symphysis is farther forward than in the jaws of *Trilophodon* from the Santa Fé beds. A large cavity is present at the front end of the jaw, but whether or not this was occupied by a large tusk can not be satisfactorily determined.

The humerus accompanying the jaw is greatly crushed and poorly preserved. The distal end is shown in Plate 2 (fig. A), where it is compared with the comparable portion of the humerus (fig. B) of the Pleistocene mastodon from Rancho La Brea. The outer tuberosity does not appear to be as well developed in the Ricardo form as in the Rancho La Brea species. The distal articulating surface is larger than in the Pleistocene humerus and differs also in having an oblique position.

The femur (Plates 2 and 3), although somewhat crushed on the posterior side, is nearly completely preserved and belongs to an adult individual. No. 2 is longer than a femur of the Pleistocene mastodon of Rancho La Brea in the Los Angeles Museum collection, but is shorter than that of the Warren mastodon (*Mammut americanus*). The Ricardo specimen exceeds in transverse width of proximal end the Pleistocene femur from Rancho La Brea, while the middle portion of the shaft is more slender. The head extends farther above the plane of the surface of the great trochanter and the articulating surface is directed more inward, less upward, than in the Pleistocene form. The lesser trochanter is situated higher on the inner side of the shaft while the third trochanter appears to have been more prominently developed than in the femur from the asphalt.

At the distal extremity the patellar surface has an oblique trend, is narrower, and extends farther on the anterior side of the femur than in *Mammut.* It is broadly confluent below with the inner condylar surface. In *Trilophodon?* from the Ricardo the outer condyle is distinctly narrower than the inner. The condylar surfaces appear to have extended farther on the posterior side of the shaft and are therefore seen to less extent in distal view than in *Mammut* (see Plate 3), suggesting perhaps that the femur was not carried in as erect a position in the Tertiary form as in the Pleistocene type. The intercondylar area is narrow.

On the posterior side of the proximal end (Plate 3) of the femur a noticeable difference is seen between the Ricardo and Rancho La Brea types in the width of bone lying to the outer side of the digital fossa. In *Trilophodon?* this region is much wider transversely than in *Mammut.*

The femur of *Trilophodon productus* described by Cope[6] from the Santa Fé beds, New Mexico, is distinctly longer than the Ricardo specimen. The femur figured by Cope lacks the proximal end. The shaft is quite slender and there is no indication of the third trochanter. A mastodon femur measuring 810 mm. in length and belonging to the species *Trilophodon pojoaquensis* Frick[7] from the Santa Fé deposits is somewhat shorter than No. 2 from the Ricardo.

A calcaneum, No. 5 L. A. Mus. Coll., was found in the Ricardo deposits as exposed between Red Rock Cañon and Last Chance Cañon. Illustrations of this element and of the comparable bone in the Pleistocene mastodon of Rancho La Brea are shown in Plate 4.

No. 5 is seen to differ from the calcaneum of the Pleistocene form in the following characters:

(1) The posterior end of the tuber calcis, as viewed from the side (see Plate 4, fig. C), shows a fuller development. The process itself is relatively longer and more massive.

(2) A well-defined notch behind the tendinal groove of the outer or fibular side is absent.

(3) The anterior or dorsal surface of the tuber calcis slopes upward directly to the large astragalar facet. In other words, the articulating surface is not situated on a platform distinctly removed from or well above this surface.

(4) The forward or proximal portion of the channel between the large astragalar facet and the sustentacular facet is not deep.

(5) The principal cuboidal surface is relatively small, while that for the navicular situated on the sustentaculum is relatively large.

(6) There is a large extent of bone as seen in end view (Plate 4, fig. A), below the principal cuboidal surface.

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[6] E. D. Cope, Rpt. U. S. Geog. Surv. west of the 100th Meridian. Wheeler Surv., Pt. II, vol. 4, Paleontology, p. 313, pl. 72, figs. 3, 3*a*, 1877.

[7] C. Frick, Bull. Amer. Mus. Nat. Hist., vol. 56, pp. 161 and 165, 1926.

*Measurements (in millimeters) of femur, No. 2, L. A. Mus. Coll.*

| | |
|---|---|
| Greatest length measured from top of head to distal end of inner condyle | 882. |
| Length measured from top of great trochanter to distal end of outer condyle | 825. |
| Distance measured obliquely across proximal end from head to great trochanter | 360. |
| Greatest transverse diameter of head | 141.4 |
| Least width of shaft | 122.3 |
| Greatest width of distal end | 207. |
| Width of surface for patella | 100.4 |

*Measurements (in millimeters) of calcaneum, No. 5, L. A. Mus. Coll.*

| | |
|---|---|
| Greatest length measured parallel to principal axis of tuber calcis | 186.4 |
| Greatest width measured across astragalar facets | 145.2 |
| Width of tuberosity | 84.7 |
| Greatest diameter of the larger astragalar surface | 82.3 |
| Greatest length of the sustentacular facet | 63.4 |
| Greatest transverse diameter of cuboidal facet (approximate) | 65. |

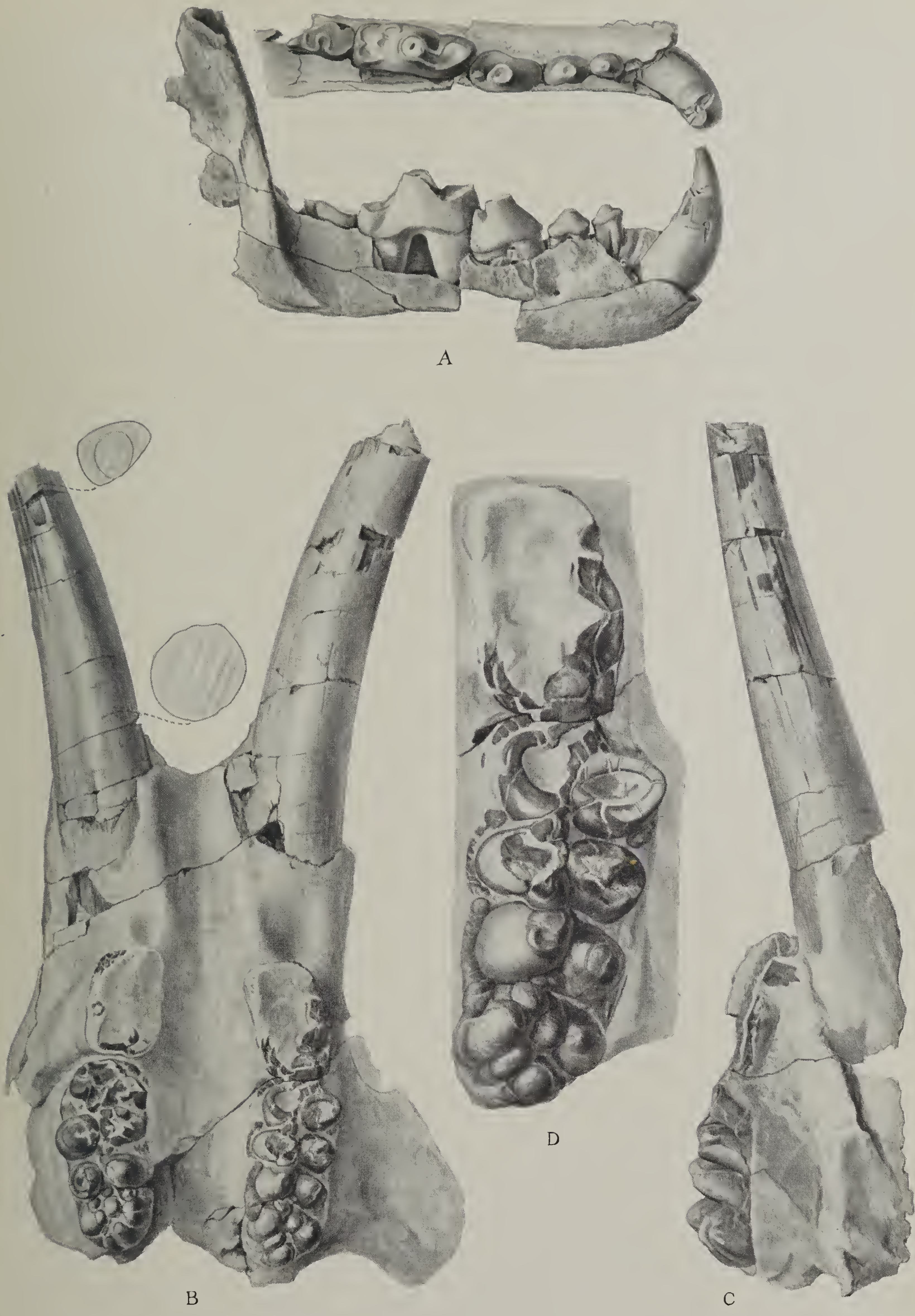

Fig. A. *Ælurodon aphobus* Merriam. Ramus of mandible, No. 6, L. A. Mus. Coll., lateral and superior views; ×0.50.

Figs. B and C. *Trilophodon* sp. Skull, No. 1, L. A. Mus. Col., inferior and lateral views; ×0.166.

Fig. D. *Trilophodon* sp. $\text{M}\underline{2}$ and $\text{M}\underline{3}$, No. 1, L. A. Mus. Coll., occlusal view; ×0.33.

Ricardo deposits, Mohave Desert, California.

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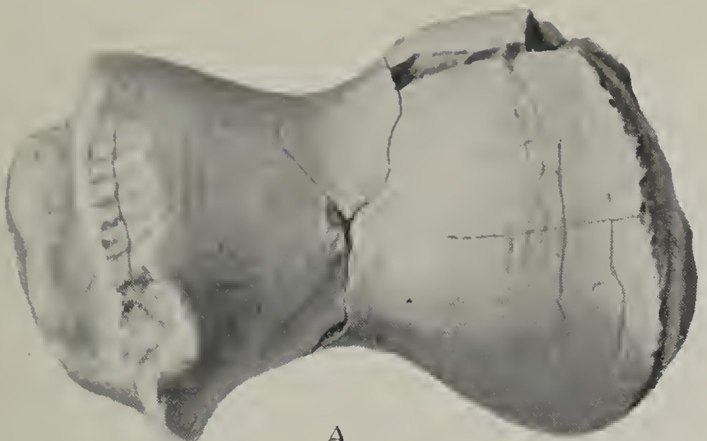

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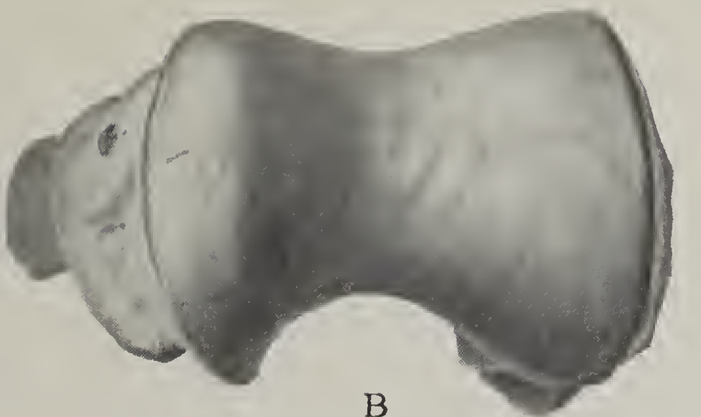

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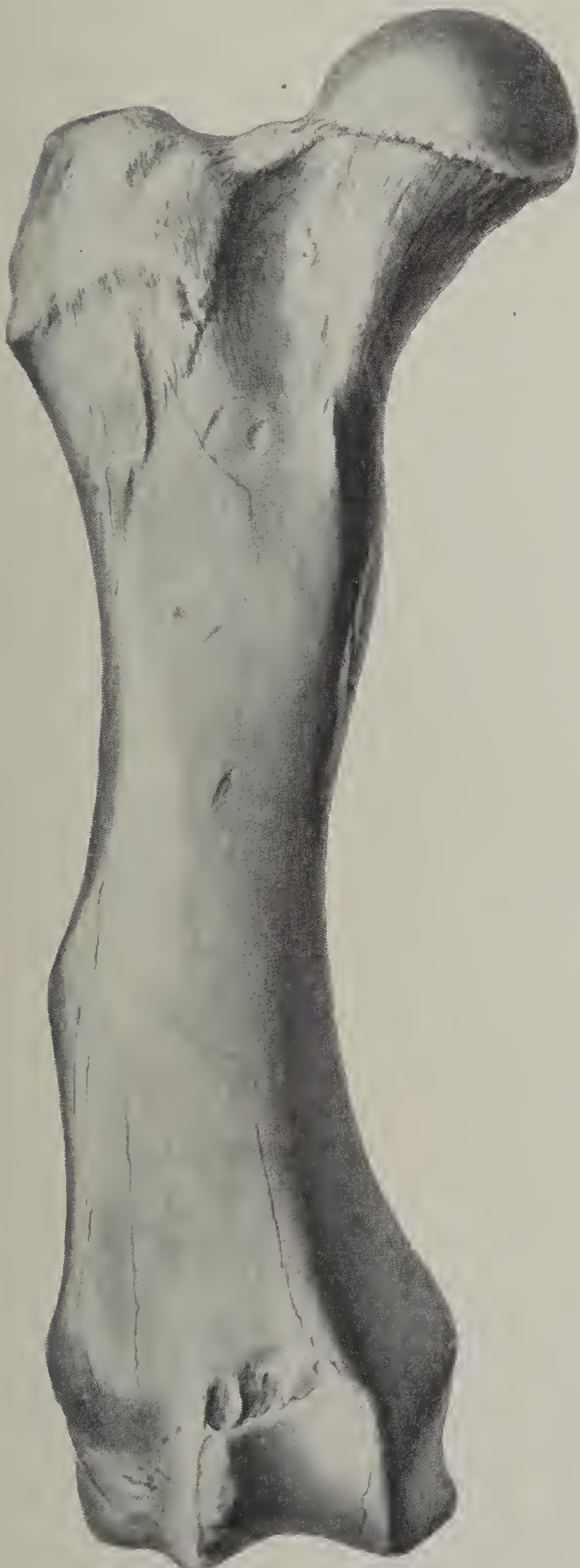

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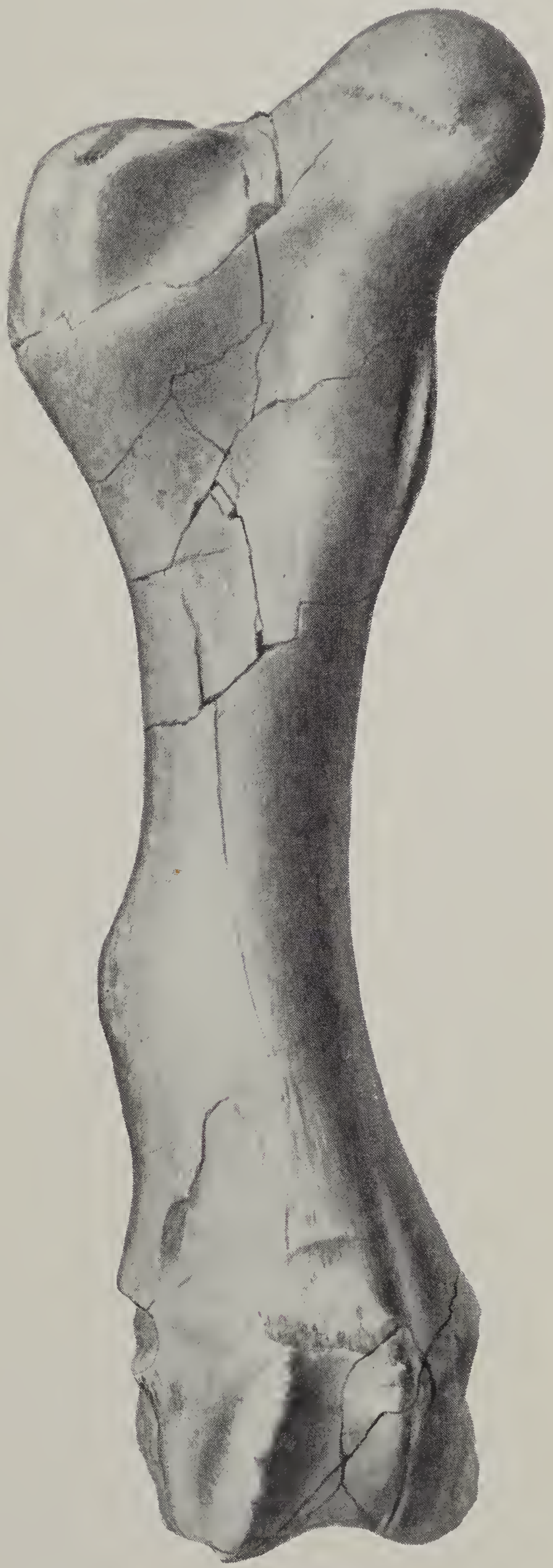


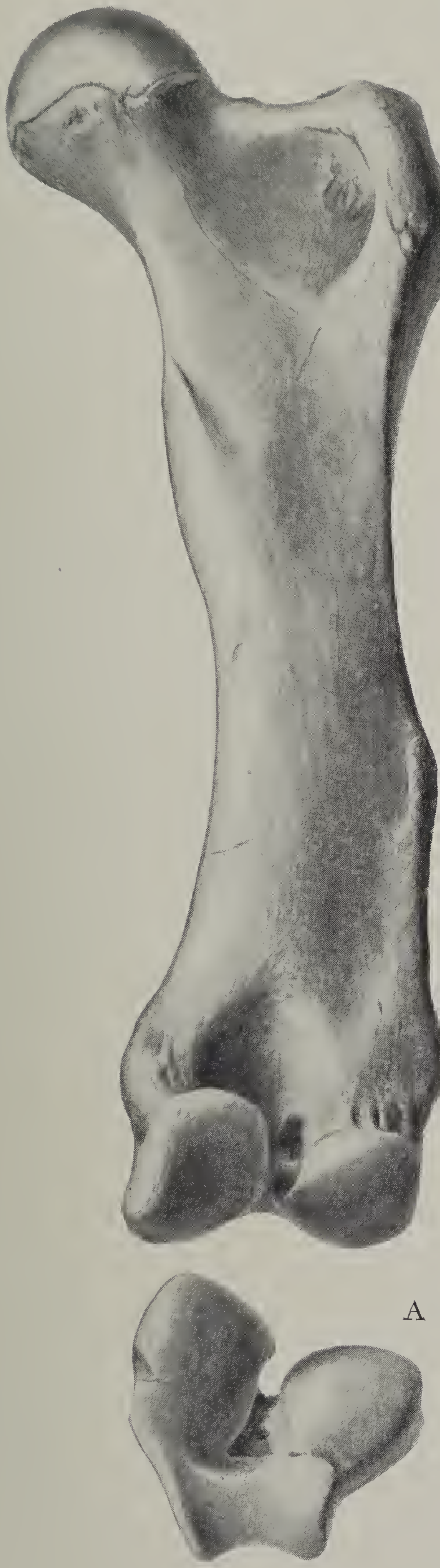
D

Fig. A. *Trilophodon?* sp. Distal end of humerus. No. 3, L. A. Mus. Coll.; ×0.25. Ricardo deposits, Mohave Desert, California.

Fig. B. *Mammut americanum* (Kerr). Distal end of humerus, No. 26006, L. A. Mus. Coll.; ×0.25. Rancho La Brea Pleistocene.

Fig. C. *Mammut americanum* (Kerr). Femur, No. 26007, L. A. Mus. Coll.; anterior crest; ×0.166. Rancho La Brea Pleistocene.

Fig. D. *Trilophodon?* sp. Femur, No. 2, L. A. Mus. Coll.; anterior view; ×0.166. Ricardo deposits, Mohave Desert, California.



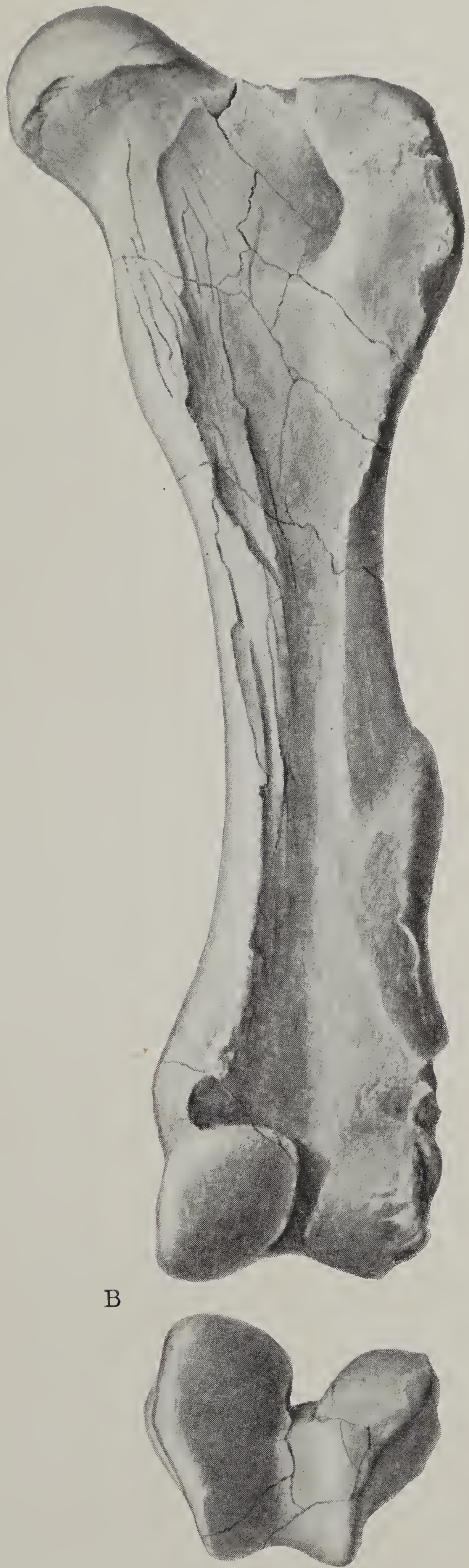


Fig. A. *Mammut americanum* (Kerr). Femur, No. 26007, L. A. Mus. Coll.; posterior and distal views; ×0.166. Rancho La Brea Pleistocene.

Fig. B. *Trilophodon?* sp. Femur, No. 2, L. A. Mus. Coll., posterior and distal views; ×0.166. Ricardo deposits, Mohave Desert, California.

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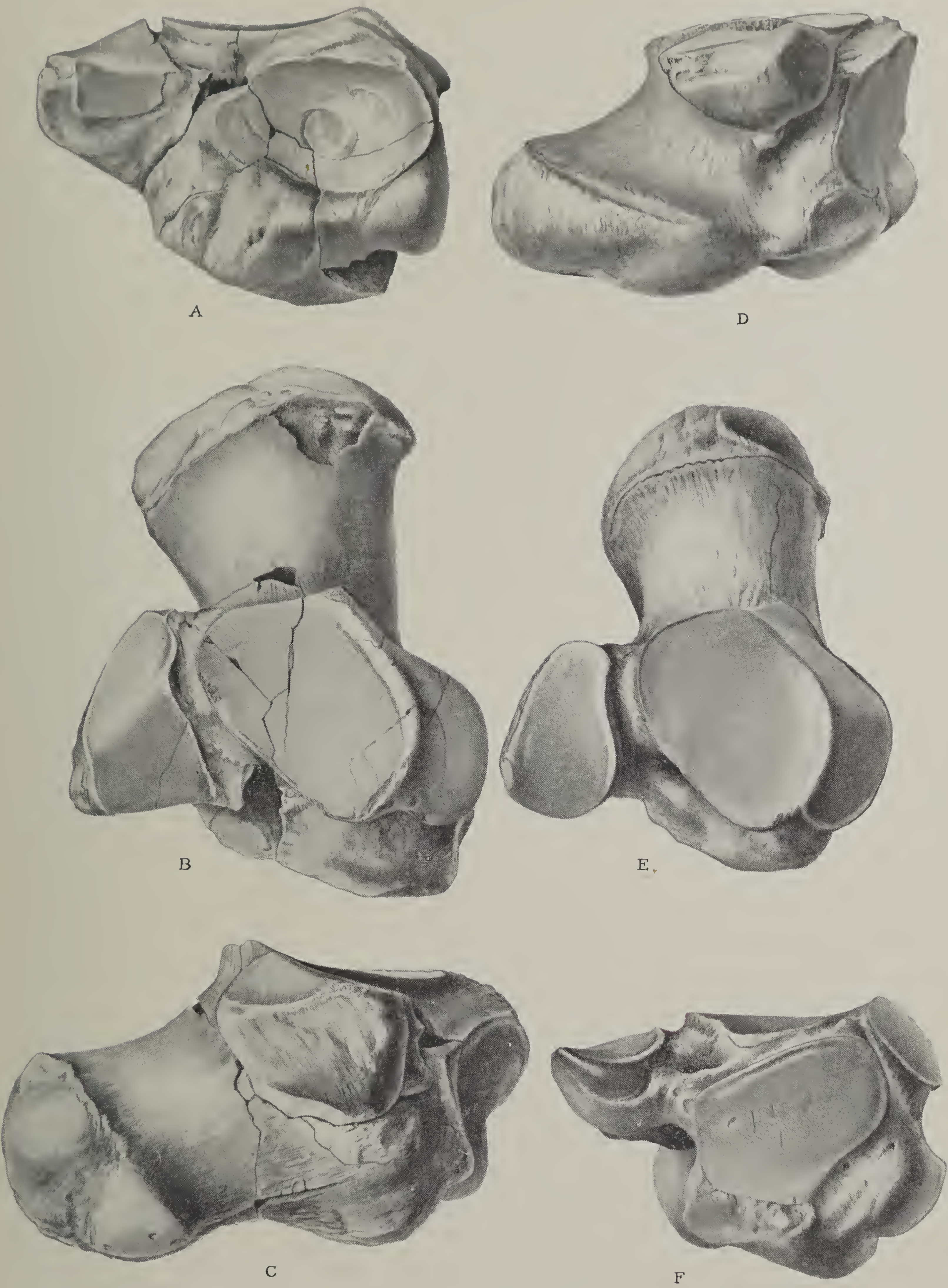

Figs. A, B, C. *Trilophodon?* sp. Calcaneum, No. 5, L. A. Mus. Coll.; A, distal view, B, superior view, C, inner view; ×0.40. Ricardo deposits, Mohave Desert, California.

Figs. D, E, F. *Mammut americanum* (Kerr). Calcaneum, No. 26008, L. A. Mus. Coll.; D, inner view, E, superior view, F, distal view; ×0.40. Rancho La Brea. Pleistocene.

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# VI

# A TOOTH OF HIPPARION MOHAVENSE FROM THE PUENTE FORMATION, CALIFORNIA

BY CHESTER STOCK

With one figure

# A TOOTH OF HIPPARION MOHAVENSE FROM THE PUENTE FORMATION, CALIFORNIA

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### BY CHESTER STOCK

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Remains of land mammals occurring in Tertiary formations of the Pacific Coast marine province of western North America furnish important data relating to the correlation of the faunal horizons of this region with those of the continental deposits of the Great Basin area to the east. The discovery in marine deposits, presumably the Puente formation of southern California, of a horse tooth identified as belonging to the species *Hipparion mohavense* Merriam, suggests at once an interesting time relationship between the Puente and the Ricardo deposits of the Mohave desert, the type locality of this species.

The tooth, No. A1331 Los Angeles Mus. Coll., was obtained by Dr. A. J. Tieje. The specimen occurred in diatomaceous shale at a locality 2.5 miles from Covina and in a direction S 77° E of the center of this community as determined on the topographic map, Pomona Quadrangle, California, of the U. S. Geological Survey.

The San Jose Hills in which the locality occurs are shown on the geological map recently published by English [1] to be largely constituted by the upper division of the Puente formation of upper Miocene age. As described by English the sedimentary deposits in the San Jose Hills represent a succession of alternating shale, sandstone and conglomerate. The particular area in which the *Hipparion* tooth was found is mapped as the upper shale member of the Puente.

English considers it possible that a portion of this shale and conglomerate series regarded as the upper Puente belongs to the Fernando, but states that "in the absence of any evidence of unconformity there is no reason to place the dividing line at any particular horizon, and as the shale zones are more like the Puente shales it seems best to include all the beds in that formation." Elsewhere in the area mapped by English the Fernando Pliocene rests unconformably above the Puente and differs lithologically from the latter in general absence of siliceous shales, in a greater abundance of conglomerates, and in the slightly less indurated state of the deposits. It is conceded, however, that there are several localities where the two formations can not be differentiated on the basis of these lithological characters.

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[1] Walter A. English, *Geology and oil resources of the Puente Hills region, southern California; with a section on the chemical character of the oil*, by Paul W. Prutzman, U. S. Geol. Surv. Bull. 768, 1926.

The tooth (fig. 1) is not water worn and does not appear to have been transported for any great distance. The specimen belongs to the upper premolar series, representing presumably P$\underline{4}$. No. A1331 resembles in size and in its enamel pattern premolar teeth of *Hipparion mohavense* from the Ricardo beds, Mohave Desert, California. The plications of the fossette borders appear to be very much like those of *H. mohavense.* This is especially true of the posterior border of the prefossette and of the anterior border of the postfossette. A single pli caballin is present. The discrete protocone closely resembles in size and in shape that in the Ricardo species. The meso-style is rather strongly developed. A heavy deposit of cement is present on the outer and inner sides of the tooth and reaches upward to a point approximately 8 mm. above the occlusal surface.

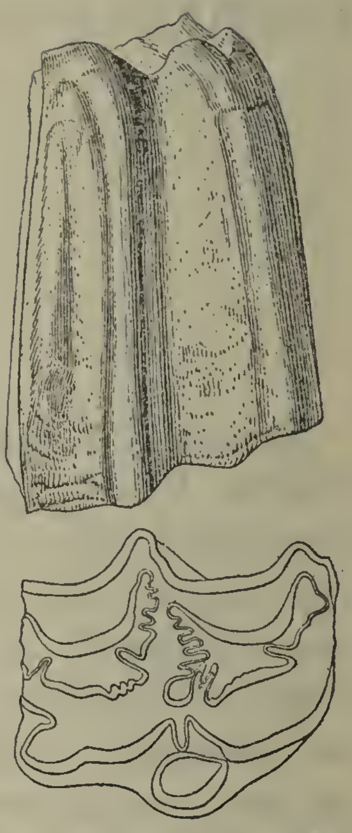

Fig. 1—*Hipparion mohavense* Merriam. P$\underline{4}$?, view of occlusal surface and outer side, ×1.0. Upper Puente deposits, San Jose Hills, near Covina, California.

The anteroposterior diameter of P$\underline{4}$, No. A1331, taken normal to the longitudinal axis of the tooth is 23.5 mm., while the transverse diameter is 22.4 mm. The greatest diameter of the protocone is 6.5 mm.

There appears to be no reason for questioning the close similarity or identity in stage of evolution which exists between the Puente *Hipparion* and *H. mohavense* of the Ricardo beds. The Ricardo fauna has been regarded as lower Pliocene in age. In recent years, however, the assemblage has been considered as belonging perhaps to the late Miocene rather than to the early Pliocene.[2] It is worthy of note that the age determination of the Ricardo is in part based upon the presence of *Hipparion* horses showing relationship to Old World representatives of this group occurring in the Pontian stage.

Prior to the discovery of the *Hipparion* tooth the Puente formation in the area mapped by English yielded no diagnostic fossils on which an age determination of this deposit could be based. The age of the formation was suggested by the fact that the Puente lies between the middle Miocene Topanga and the Pliocene Fernando. The occurrence of *Hipparion mohavense* in beds of the upper portion of the Puente furnishes evidence that the deposits are either lower Pliocene or uppermost Miocene in age. If we accept the view that the genus *Hipparion* appeared in North America in the late Miocene, then the presence of *H. mohavense* in the Puente would lend further support to this view, since the Puente has been correlated with upper Miocene formations rather than with lower Pliocene deposits on the basis of independent stratigraphic evidence.

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[2] For a recent discussion of the correlation and age of the Ricardo fauna see C. Stock and E. L. Furlong, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 16, pp. 51–53, 1926.

Support of this view is, however, lessened somewhat by the fact that the upper Puente deposits in the San Jose Hills may belong, as stated above, to the Fernando marine formation of Pliocene age, a possibility suggested by English. Should this prove to be the case the presence of an *Hipparion* tooth in these beds might then be regarded as evidence confirming the Pliocene age of these deposits, particularly if we grant the lower Pliocene age of the Ricardo fauna. The Fernando in the area mapped by English is considered as being middle Pliocene in age. This determination is based upon the relationship of the marine invertebrate fauna to that of the Fernando in adjacent regions. The occurrence of *Hipparion mohavense* in the Fernando should then be regarded as the result of survival of the species in the middle division of the Pliocene.

In the later Pliocene faunas of the Great Basin region the *Hipparion* horses are principally if not entirely of the *Neohipparion* type with elongate protocone in the upper teeth. In the California province, species with shortened and rounded protocone, possibly related to *H. mohavense,* have been recorded from the Siestan Pliocene of the Berkeley Hills.

While insufficiency of vertebrate material from the locality in the San Jose Hills and the questionable age determination of the upper Puente deposits in this region leave much to be desired in the correlation of the formation with continental deposits of the Great Basin, the occurrence of *Hipparion mohavense* in beds associated with marine formations in southern California possesses considerable interest, since it further suggests the possibility of an appearance of the *Hipparion* group in the late Miocene of California.

## VII

# MERYCHIPPUS ISONESUS (COPE) FROM THE LATER TERTIARY OF THE CROOKED RIVER BASIN, OREGON

BY JOHN H. MAXSON

WITH ONE TEXT-FIGURE

# MERYCHIPPUS ISONESUS (COPE) FROM THE LATER TERTIARY OF THE CROOKED RIVER BASIN, OREGON

By John H. Maxson

Although Tertiary deposits, presumed to be the correlative of the Mascall and Rattlesnake formations of the John Day basin, are known to occur in the Crooked River basin south of the Ochoco Mountains in central Oregon, no vertebrate fossils of diagnostic value have been obtained from these beds. Merriam and Sinclair[1] record the finding of a caniniform premolar of a merycoidodont in Mascall beds exposed on the divide between Camp Creek and the Crooked River. Recently R. W. Chaney[2] has reviewed the evidence on which is based the recognition of the Mascall horizon in the Crooked River region.

In the course of palæontological investigations conducted in central Oregon under the leadership of Dr. Chester Stock, an upper tooth of *Merychippus* was collected in deposits, regarded as Mascall in age, along the Crooked River between Post and Paulina. In view of the opportunity to compare the stage of evolution of this specimen with that represented by the dentition of the merychippine forms from the type Mascall, a description seems desirable. The writer wishes to acknowledge the guidance of Dr. Stock during the progress of this study.

## OCCURRENCE AND NATURE OF THE DEPOSITS

From Paulina, Crook County, Oregon, to a point west of Post the Crooked River pursues a general east-west direction, whence it flows northwesterly to its junction with the Deschutes River. In the vicinity of Post it crosses a broad north-south anticline where it has excavated a basin, cutting into the Clarno formation. Several miles west of Post the Crooked River enters a narrow gorge with abrupt basalt walls. These Columbia basalts continue along the south flank of an east-west anticline whose axis lies north of Prineville and south of Mitchell.

In the structural basin southeast of these folds occurs a late Tertiary series of terrestrial deposits. At the fossil locality the exposed portion of the formation superadjacent to the Columbia basalts consists largely of grayish tuffs and sand. Above these deposits rests an extrusive of rhyolitic character.

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[1] J. C. Merriam and W. J. Sinclair, Univ. Calif., Publ. Bull. Dept. Geol., vol. 5, p. 196, 1907.

[2] R. W. Chaney, Carnegie Inst. Wash. Publ. No. 346, pp. 45–138, 1927.

The complete tooth described herein was collected in four scattered fragments whose position indicated a source but a few feet beneath the base of the flow. The exposure is approximately 0.5 mile northwest of the W. A. Carson ranch house, which is on the Crooked River about halfway between Post and Paulina. Its location is in the S ½ of S ½ Section 2, T 17 S, R 21 E, Willamette Meridian. Unfortunately additional materials from this locality include only fragments of teeth of horse and rhinoceros.

## DESCRIPTION OF SPECIMEN

The tooth, No. 13, Calif. Inst. Tech. Coll. Vert. Pale. (fig. 1, *a*, *b*, *c*), is a left upper premolar three or four, showing a comparatively slight amount of wear.

*Dimensions*—Anteroposterior diameter 19.6 mm.; transverse diameter 20.5 mm.; outside length 25.8 mm.; inside length 12.2 mm.

In size it is larger than *Merychippus seversus* and almost identical with that of the type *M. isonesus* described by Cope.

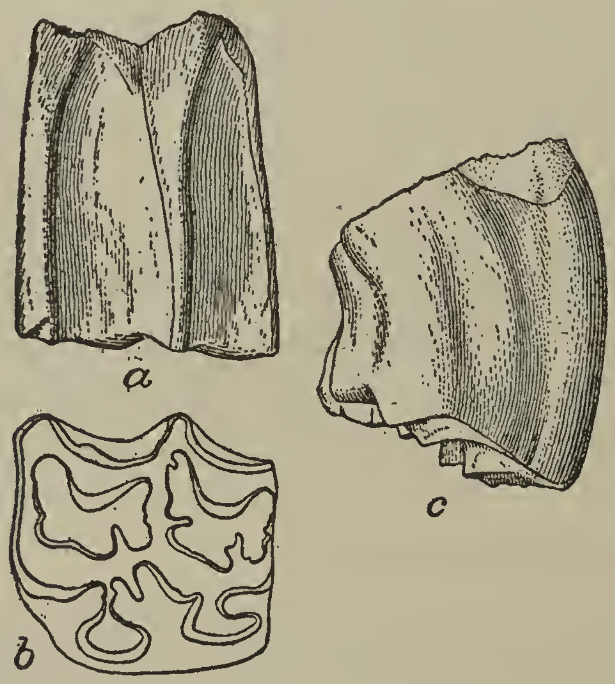

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Fig. 1, *a*, *b*, and *c*—*Merychippus isonesus* (Cope). Superior premolar, No. 13, natural size. Late Tertiary beds, Crooked River basin, Oregon. *a*, outer view; *b*, occlusal view; *c*, anterior side.

The tooth is quite heavily coated with cement and possesses moderate curvature. Protocone and hypocone are subequal in size, the former being oval with a long isthmus, while the latter is elongate and appressed. The hypocone is strongly united to the metaconule at an early stage of wear. The protocone shows more wear than the hypocone, yet it is but weakly connected to the protoconule by a long slender isthmus.

The fossette borders are comparatively simple. The post-fossette has two major plications, a pli hypostyle and a pli post-fossette. The pre-fossette has merely a pli crochet. A pli caballin is present.

The characters in which this form differs from *Merychippus isonesus*, namely, a slightly larger size, the early union of protocone and protoconule, and the comparative simplicity of the fossette borders, might be interpreted as showing a somewhat different stage for the Crooked River species. However, the form represents very nearly *M. isonesus* in development of tooth crown and enamel pattern. It thus furnishes evidence suggesting that the beds from which it comes are the correlative of the Mascall formation at the type locality in the John Day valley which yielded the species *M. isonesus*.

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